CONTEXTUAL ASPECTS OF OTHER ANIMAL STRESS CUES IN AVOIDANCE ACQUISITION

Murray J. Dobson

A thesis submitted to the University of Canterbury in fulfilment of the requirements for the Degree of Doctor of Philosophy in Psychology

1 August 1985

ACKNOWLEDGEMENT

This thesis was long in gestation and sometimes painful in birth.

I thank my family, Liz, Renwick and Rohan, and my long-suffering supervisor, Rob Hughes, for their forebearance and patience. They had faith that it would eventually emerge, even when I did not.

TABLE OF CONTENTS

	Acknowledgement	ii
	List of Tables	iv
	List of Figures	v
	Abstract	vii
Chapter 1	Introduction.	1
Chapter 2	Other Animal Effects. Theoretical Concepts.	10
Chapter 3	Other Animal Effects in Avoidance. The Present Investigation.	26
Chapter 4	The Experiments	44
	Experiment 1	44
	Experiment 2	58
	Experiment 3	70
	Experiment 4	85
	Experiment 5	94
	Experiment 6	102
Chapter 5	General Discussion	113
	References	130
Appendix A	Effect of Danger and Safety Signals in the Goal Chamber on Avoidance Acquisition: A Pilot Experiment.	139
Appendix B	Analysis of Variance Summary Tables	148

LIST OF TABLES

Table 1	Mean number of avoidance responses/ block of 10 trials (Experiment 1).	50
2	Mean transformed response latencies (log (x+1)) (Experiment 1).	53
3	Mean number of avoidance responses/ block of 10 trials (Experiment 2).	61
4	Mean transformed response latencies (log (x+1)) (Experiment 2).	64
5	Comparison of location times and avoidance acquisition. Results obtained by Dua (1975) with location times in current experiments.	67
6	Mean number of avoidance responses/ block of 10 trials (Experiment 3).	74
7	Mean transformed response latencies (log (x+1)) (Experiment 3).	78
8	Mean number of avoidance responses/ block of 10 trials (Experiment 4).	88
9	Mean transformed response latencies (log (x+1)) (Experiment 4).	90
10	Mean number of avoidance responses/ block of 10 trials (Experiment 5).	97
11	Mean transformed response latencies (log (x+1)) (Experiment 5).	99
12	Mean number of avoidance responses/ session for shuttle avoidance of Model Shocked, Model Not Shocked, and No Model groups (Experiment 6).	106
13	Mean transformed response latencies (log (x+1)) in shuttle avoidance for Model Shocked, Model Not Shocked and No Model groups (Experiment 6).	108

LIST OF FIGURES

Figure 1	Avoidance acquisition as a function of shock intensity to model animals (Dua and Dobson, 1975).	36
2	Avoidance acquisition as a function of shock duration to model animals (Dua and Dobson, 1975).	37
3	Comparison of avoidance acquisition for groups with model in goal and start chambers and no model control. (Experiment 1).	51
4	Transformed response latencies during avoidance acquisition (Experiment 1).	54
5	Profiles of model location x model condition interaction for transformed latency data (Experiment 1).	56
6	Comparison of avoidance acqusition for groups with S_T in start or observation chambers (Experiment 2).	62
7	Transformed response latencies during avoidance acquisition (Experiment 2).	65
8	Comparison of avoidance acquisition for groups in which S_T was handed or not handled (Experiment 3).	75
9	Profiles of S_T treatment x S_M condition for mean total avoidance responses.	77
10	Transformed response latencies during avoidance acquisition (Experiment 3).	79
11	Profiles of S_T treatment x S_M condition interaction for transformed latency data (Experiment 3).	80
12	Demonstration of drive hypothesis on effects of handling by shifting interaction profiles of handling vs no handling	84
13	Comparison of avoidance acquisition for groups in which model was adjacent to start and goal chambers (Experiment 4)	89

Figure 14	Transformed response latencies during avoidance acquisition (Experiment 4).	91
15	Comparison of avoidance acquisition for groups with model shocked or not shocked in line with safe chamber and no model control (Experiment 5).	98
16	Transformed response latencies during avoidance acquisition (Experiment 5).	100
17	Comparison of shuttle avoidance acquisition for Model Shocked, Model Not Shocked and No Model groups (Experiment 6).	107
18	Comparison of transformed response latencies in shuttle avoidance for Model Shocked, Model Not Shocked and No Model groups (Experiment 6).	109

ABSTRACT

Fear or stress cues are considered to be important in evolutionary survival. Hence, such cues are likely to be important and powerful in inter-animal interactions. In aversive situations animals should be maximally attuned to cues providing information about the safety or danger of various elements of their environment. The present series of experiments with albino rats studies the inhibitory effect on avoidance acquisition of the presence of a stressed (shocked) model animal in the safe chamber of a hurdle-jumping apparatus.

Three main theories are considered: (a) that because the model receives inescapable shock, a process of vicarious instigation of helplessness leads to inhibition of avoidance acquisition; (b) that increased arousal produced by the shocking of a model adds to the already high arousal of the subject, leading to decreased performance; and (c) that situational cues provided by the stressed model modify the perception by the test animal of the safety or danger of environmental elements.

The results of the experiments support neither the vicariously instigated helplessness nor the increased arousal hypotheses. Rather the subject appears to be using situational cues provided by the stressed model within the context of the safe/dangerous environment. Further, evidence that the inhibitory effect occurs, though not as strongly, when the model is shocked in a third chamber in line with the safe chamber in a one-way avoidance task and also in two-way shuttle avoidance suggests that the nature of the situational information comes from directional rather than place cues. The results are discussed in terms of cognitive theories of avoidance.

CHAPTER 1

INTRODUCTION

Fear, as a basic drive, has an important role in the evolutionary process. Any mutation that reduced the tendency of an animal to react fearfully in a hostile environment would decrease its chances of survival. Only in species which depend on the production of large numbers of progeny (e.g. insects) is fear thought not to be a powerful motivator of behaviour. In such cases, the survival of any particular individual is not as important as the statistical probability that sufficient numbers will reach maturity to maintain the species population. In species where the progeny produced are smaller in number and take longer to reach maturity, the survival of individuals becomes important to the success of the species (Leyhausen, 1973). It is in these species that fear plays an important role.

Leyhausen (1973) suggests that fear forms part of a "propensity system" dependent on basic physiological processes and continuously maintained around a level which is predetermined

by evolutionary forces. In any particular species the level corresponds to the average degree of danger in the environment in which the species developed. Variations in tension can be clearly seen in comparing the behaviour of different species in situations such as, for instance, on the African plains where most prey animals are in a constant state of relatively high alertness and fearful behaviour is exhibited fairly often to a variety of stimuli; while predators, on the other hand, appear much more relaxed.

Leyhausen's notion of basic constitutional differences amongst animals which are associated with different levels of fear propensity appears to have some empirical support. Funkenstein (1955) has claimed that there are differences among higher animals in the ratio of noradrenaline to adrenaline levels in the adrenal medulla. In aggressive predatory species, such as the lion, noradrenaline is reported to predominate, while in timid prey animals, such as the rabbit (as well as in domestic animals and social species such as the baboon), the noradrenaline/adrenaline ratio is lower. Data outlined by West (1955) tends to support this hypothesis if only mammals are considered, although the pattern is not completely straightforward.

The relationship between noradrenaline/adrenaline ratio and fear and aggression is fairly well established (Buck, 1976), but as Buck suggests, it is a correlation and it is not clear what the constitutional process which determines the balance

is, although it has been suggested that the balance may be determined in the hypothalamus (Gellhorn, 1976). The important point for our purposes is, however, that there are basic and consistent differences across species which appear to coincide with observed behavioural differences in fear propensity.

It is well known amongst animal breeders that temperament characteristics can be selectively bred. Indeed domestication of most species leads to a reduction in fearful propensity, along with important changes in the endocrine system which entail a reduction in adrenal gland size and efficiency (Gray, 1971). In the laboratory, selective breeding of rats and mice have led in 7 or 8 generations to stable strains showing high or low emotionality or fearfulness as measured on various objective measures, such as open field tests of defaecation, urination and ambulation, emergence tests and response suppression (Broadhurst, 1960; Gray, 1971; Hall, 1941, 1951).

While the propensity to respond in a fearful way has an average innate level for a particular species, clearly there is not a constant state of fearfulness. Indeed, this is not surprising, as the effects of constant and prolonged stress would tend to lead to negative selection. Prolonged stress results in a reduction in bodily functions directed towards reproduction, growth, resistance to infection and the ability to close wounds (Gray, 1971). Fertility and sexual behaviour are suppressed by reduction in the secretion of gonadotrophic hormones by

the anterior pituitary. This leads to a reduction in the production of spermatozoa, a reduction in the secretion of testosterone and delayed or complete suppression of puberty in the male. In the female there is disruption or suppression of the oestrous cycle, decrease in the weight of the uterus, inability to ovulate, failure of fertilized ova to implant, increase in spontaneous abortion and failure in lactation. Growth is inhibited by a depression in thyroid activity. Increased production of glucocorticoids by the adrenal cortex leads to a reduction of imflammatory processes and a decrease in the ability to resist infection. There must therefore, be a fine balance between readiness to respond fearfully and yet not remain in a condition of constant fearfulness for prolonged periods. This suggests that, in addition to the selection of the propensity level, there must also be selection of specific stimuli in the environment that elicit fear.

There are a variety of fear eliciting stimuli in an animal's environment which can be categorised into two classes according to origin: (a) unconditioned or innate, and (b) conditioned.

a) Unconditioned fear eliciting stimuli elicit fear because they are associated with elements in the environment that have, in the evolutionary sense, been selected as dangerous. Hence, the tendency to respond fearfully to them has increased the probability of survival. The nature of innate fear eliciting stimuli is often manifested in unlearned preferences which animals display. For instance, preferences for black vs white,

darkness vs light, and familiar vs highly novel have been experimentally shown in rats (Allison et al, 1967; Aulich and Vossen, 1978), and preference for darkness or dim light has been shown in cactus mice (Kavanau, 1978). While all preference data are not necessarily evidence of innate fears, the strength and persistence give us a clue to their origin. In many cases it can be seen that avoidance of the non-preferred stimulus will persist even when aversive stimulation is associated with the preferred stimulus (Allison et al, 1967; Aulich and Vossen, 1978).

Gray (1971) has classified fear eliciting stimuli according to four principles: intensity, novelty, special evolutionary danger, and social interaction with conspecifics. Stimuli may be physical attributes of particular objects, such as colour, shape or tone, or they may be non-specific qualities, such as strangeness, motion or intensity (Gray, 1971; Hebb, 1949).

The innate fear eliciting tendency of a stimulus may vary in an individual according to developmental sequence, so that stimuli that may be fear eliciting at one stage may not be at another. Attraction to or avoidance of a stimulus, or pattern of stimuli, may be seen to change at various ages, or vacillate (Gray, 1971; Kavanau, 1978; Rachman, 1974; Sluckin, 1964). As a general trend, the fear eliciting potential of intense and novel stimuli decrease with age, while that associated with predators and social interactions increase.

The presence of conspecifics is an important element in the environment of most higher animals. These will take the form of parent, mate or member of a social grouping. Aggressive behaviours emitted by conspecifics as part of the social interaction form one class of other-animal produced fear eliciting stimuli. This interaction maintains personal space, leads to the acquisition and retention of territory, and the development of hierarchies within a social grouping. While some of these behaviours will have arisen as the result of previous conditioning (attacks by conspecifics are rarely fatal; McFarland, 1985) it is clear from the stereotyped submissive responses that occur in many species, that the stimuli and the responses to them are innate.

Another important class of fear eliciting stimuli provided by the behaviour of conspecifics, is that associated with responses to dangerous elements in the environment. In some cases, the behaviours may have become stylised, such as vocal calls, tail flashing or thumping. In others, the stimuli are not stylised signals, but are emitted by the other animal as part of its behaviour under stress, such as when fleeing or in pain. Both sorts of other-animal produced danger warning stimuli may extend their effects across species, where different species share a common environment.

The presence and importance of explicit warning signalling behaviours will tend to vary amongst species, having been

selected by environments of greater or lesser hostility. They are also likely to be more prevalent amongst 'social' species. Stress-related stimuli, on the other hand, should be more generally present. They are also likely to be powerful in eliciting fearful responses of various sorts, e.g., avoidance, alarm, fleeing and hiding. Most of us are introspectively aware of the spine-chilling, hair-raising effect of the human scream.

Of the various sorts of innate fear eliciting stimuli, it is those produced by stressed animals that are the concern of the present study. It is probable that to some extent both danger signalling and stress related stimuli tend to occur together, and there is no attempt to separate them in the experimental procedures used in this investigation. Indeed, it is difficult to see how they might be separated as a stressed animal may well be signalling as well as emitting stress stimuli, while a danger signalling animal, though perhaps not in pain, will usually be exhibiting signs of stress.

b) Conditioned or acquired fear eliciting stimuli arise from the conditioning history of the individual animal in two ways. First, by association with aversive stimuli (e.g., pain) which may be contingent (i.e., causally related) or non-contingent (i.e., coincidentally occurring by chance). Second, by association with unconditioned fear eliciting stimuli, without any necessary associated aversive consequences.

The patterning in the environment of both unconditioned and conditioned fear eliciting stimuli form the means by which the individual animal gains information about the comparative safety or danger of parts or elements of its surroundings. The relationship between the unlearned and acquired fear S-R systems is incorporated in Bolles' (1970, 1975) notion of the species specific defence reaction (SSDR) and Seligman's (1970) concept of preparedness. According to these, S-R associative systems are differentially prepared according to evolutionary selection of stimuli and responses. Hence, it may be more difficult to condition a response (e.g., bar press) to any stimulus in an aversive situation (e.g., shock) because of a stronger competing SSDR (e.g., freezing), than when the response is compatible with an SSDR (e.g., jumping or running) (Bolles, 1970, 1975). On the stimulus side, the premise of equipotentiality frequently advanced, either explicitly or implicitly, can be shown to be inadequate by evidence of differential learning rates using different sorts of stimuli (both CS and UCS). The fact that the animal brings to the learning situation an associative apparatus as well as a sensory-motor apparatus, both shaped by evolutionary history, may make certain contingencies easier to learn, more difficult to forget, more readily generalizable, etc (Seligman, 1970; Seligman and Hager, 1972). Seligman (1970) has proposed a dimension of preparedness along which stimulus input/behaviour output associations vary. The number of pairings required to produce reliable responding is the measure which

defines this dimension as a continuum from instinctual phenomena at one end to learning phenomena at the other.

The preparedness hypothesis has been advanced to account for features of human phobias that cannot be satisfactorily explained by more traditional classical fear conditioning theories based on equipotentiality of stimuli (Rachman, 1978; Seligman, 1972). According to this hypothesis many human phobias have their roots in man's evolutionary history. Particular stimuli (e.g., snakes, darkness, heights, etc) occur frequently, while phobias about modern objects and situations (e.g., electric power plugs, tones, lights and common household appliances) are far less common. The features of prepared conditioning are that they are rapidly acquired, resistant to extinction, highly selective in CS and 'non-cognitive'. These are also the important features of phobias (Seligman, 1972).

It is clear from the evidence and theoretically from the evolutionary point of view that there is considerable preparation of stimuli and responses operable in both human and animal behaviour. In many species much of the prepared behaviour is evident in the interaction between conspecifics (and probably between species as well). Interanimal interaction appears to provide important information for the animal about the features of its environment.

CHAPTER 2

OTHER ANIMAL EFFECTS
THEORETICAL CONCEPTS

Galef (1976) has pointed to the rather confusing array of concepts and terminology that characterises the psychological literature on various aspects of the ways the behaviour of one organism influences the behaviour of another. Some use descriptive terms like 'social facilitation' which obscure differences in underlying mechanisms; others use terminology reflecting hypothesised underlying mechanisms mediating observed behavioural interaction (coaction, local enhancement, matched dependent behaviour, copying); and yet others employ operationally defined categories (following, observational learning). This confusion of terminology has resulted from the replacement of analyses of instances of social learning by a rather arbitrary labelling of inadequately explored phenomena. As Galef suggests, the problems with attempting to classify the possible social processes resulting in the transmission of complex behaviour are probably not just semantic in origin. With such a wealth of possible interactions

there are difficulties in attempting to subsume a wide range within a limited conceptual framework.

In this chapter we consider two concepts that appear relevant to the current investigation.

Social Facilitation

The concept of "social facilitation" (Bond and Titus, 1983; Crawford, 1939; Geen and Gange, 1977; Smith and Ross 1952; Zajonc, 1965) or "coaction" (Allport, 1924) has been developed to aid understanding of the effects that the presence of an animal has on the behaviour of another. At the basis of the facilitation concept is the notion that the presence of other animals is a source of arousal which energises all responses in the stimulus situation of the time, but particularly affected is the dominant response which will have increased likelihood of emission. This arousal is said to have properties and consequences of a generalised drive state, D, as specified by Hull and Spence (Zajonc, 1969). The enhancement of the dominant response hypothesis can account for both faster and slower learning on any particular task. The presence of a coactor will be beneficial if the stimulus situation brings out primarily correct responses and detrimental if it enhances incorrect or competing responses (Zajonc, 1969).

The basic social facilitation experiments have the test animal in a situation with a model or models and test the degree to which the frequency of a specified consummatory response,

such as feeding, is increased (Harlow, 1932; Harlow and Yudin, 1933; James, 1953, 1960; Tolman, 1964, 1965; Tolman and Wilson, 1965), the rate of learning is enhanced or inhibited (Dua, 1977), or the reinstatement of a previously suppressed response occurs (Hake and Laws, 1967; Masserman, 1943).

Evidence from these latter suppression experiments and from experiments on the incidence of approach-avoidance responses (Rasmussen, 1939), the activity response (Davitz and Mason, 1955) and exploration (Hughes, 1969) suggest that fear reduction is an important element in social facilitation. This interpretation, however, seems not to accord with the supposed arousal inducing properties of the social facilitation effect for two reasons. First, it is usually felt that fear indicates a higher state of arousal and thus fear reduction would suggest a reduction of arousal. Second, fear responses are usually compelling and hence tend to dominate in fear inducing situations. Hence, from the interpretation that the presence of another animal induces a generalised drive state which enhances dominant responses we would not expect a reduction in fear, rather the generalised drive would add to the already present high arousal of the fear state and fear responses, such as avoidance, freezing, low activity, decreased exploration, etc., would be enhanced. This line of argument would lead us to either reject the hypothesis that the presence of a coactor induces higher arousal, or the hypothesis that fear

reduction is the mechanism by which performance is enhanced in tasks where it might reasonably be supposed that fear is suppressing responses or inhibiting activity.

Zajonc (1965, 1969) reviews independent evidence on endocrine activity that indicates that the presence of others is a source of arousal. In monkeys and humans (Mason and Brady, 1964) and in mice (Thiessen, 1964a, 1964b) there appears to be heightened endocrine activity (increased adrenal weights, elevated hydrocortisone levels, intensified susceptibility to excitation by amphetamine) in the presence of others. Behavioural evidence of the influence of other animals in non-fear eliciting circumstances such as feeding following satiation (James, 1953), feeding at different levels of satiation (Tolman and Wilson, 1965) and disruption of DRL performance by increased bar pressing (Wheeler and Davis, 1967) appear to indicate that the presence of another animal increases activity. Clearly, there is good evidence for the arousing effects of other animals. This would suggest that there are difficulties in positing fear reduction as the mechanism for enhancing performance in social facilitation studies.

In considering observational learning, Davey (1981) makes three objections to fear reduction being a major mechanism in enhancing learning when the subject observes the peformance of a conspecific:

(1) observational learning occurs when the observer performs alone after the observational experience;

(2) subjects observing a naive model do not learn as quick as those observing an experienced model and there is no reason to suppose that naive and experienced models should differ in their fear reducing characteristics; and

(3) observational learning has been shown to occur between species (gerbils and rats) and it is "difficult to see how a rat's anxiety can be reduced by being placed adjacent to an animal that is not a conspecific" (p. 271). He suggests that the first two objections can also be raised to arousal increase as the main enhancing mechanism.

Observational learning phenomena form a subset of the wider class of phenomena of social facilitation. While social facilitation in its pure form does not require the coactor to perform but merely to be present, in many cases the subject is stimulated by the behaviour (e.g. pecking, feeding) of the coactor. In observational learning situations the model is required to perform specific behaviours and is, perforce, always present at some stage. Davey's objections may, therefore, apply to the arousal and fear reduction hypotheses of social facilitation.

It is true that in some experimental circumstances the subject is required to perform alone but there is also considerable evidence to suggest that it is not only the actual presence of another animal that will influence the behaviour of a subject but it is sufficient in some circumstances to have the presence

of residual odors left by the model. There is clear evidence that the presence of odours from another rat (King and Dua, 1970), rewarded vs non-rewarded rats (Amsel, Hug and Surridge, 1969; Collerain and Ludvigson, 1972; Means, Hardy, Gabriel and Uphold, 1971; Mellgren, Fouts and Martin, 1973; Morrison and Ludvigson, 1970) stressed vs nonstressed rats (King, 1969; Mackay-Sim and Laing, 1980, 1981a, 1981b) and mice (Sprott, 1969), and living vs dead rats (Carr, Landauer and Sonsino, 1981) can be discriminated by conspecifics. This evidence suggests that the actual presence of a coactor is not required for other animal effects like social facilitation to occur, all that is required is that there be discriminable cues of the presence of another animal, such as odours.

Davey's second objection based on evidence that observers of naive models do not learn as quickly as observers of experienced subjects is more difficult to refute. It is possible that subjects are being influenced by rewarded odour cues more in the case of experienced models than in the case of naive models. It is clear from the evidence cited above that rats, at least, are able to discriminate these cues. What implications these differential cues have for either fear reduction or increasing arousal is not clear. Certainly in experimental situations where aversive stimuli are being used it is probable that both fear and arousal would be affected, an experienced model would tend to be less stressed than a naive one. However, at least one study (Del Rosso,

1975) of observational learning of an avoidance acquisition task using experienced and naive models found no differences between these groups.

Why Davey should see a difficulty with interspecies fear reduction (or conversely instigation), is not at all clear. There seems to be no reason why animals from different species should not influence each others fear levels. As indicated earlier in environments where different species are frequently in contact, such as on the African Plains, there is frequent cross-species arousal and fear interaction. Experimentally, jackdaws have been shown to respond with avoidance to recorded herring gull distress calls. This result is in accord with field observations of interspecies responses to distress calls in jackdaws and other species (Morgan and Howse, 1973). It is noteworthy that Davey does not raise this objection to arousal influences across species.

In each of the arguments against Davey's objections it has been necessary to appeal to discriminative cues which indicates the state of the model animal to the observer. This goes beyond the simple concept of social facilitation being brought about merely by the presence of another animal or any hypothesis that either fear reduction or arousal increase stems solely from that fact. The evidence suggests that the state of the model animal is important in the way it influences the behaviour of the subject. What information is conveyed

by the model will depend on the circumstances of the experimental set-up. In some cases it may be information about the consequences of particular responses, R-S relationships; in others information about the relationships of various elements in the stimulus environment, S-S relationships; and in yet others information about stimulus combination that require a particular response, S-R relationships (Davey, 1981). As Davey suggests it is difficult to tease out which of these types of relationship an animal might be attending to in many experimental set-ups.

Local enhancement is a term that has been used to refer to effects of a model's behaviour in directing another animal's attention to a particular part of the environment, thereby enhancing stimuli that are critical in the learning situation. Thus, approach to a particular part of the environment is facilitated by the presence of another animal thereby drawing attention to that part of it.

Vicarious Instigation

The phenomena of vicarious instigation and vicarious conditioning have been reviewed by Green and Osborne (1985) and Thelen and Rennie (1972). Green and Osborne (1985) define vicarious instigation as "the occurrence of an unconditioned emotional response of an observer dependent on the observer's inference or perception of the unconditioned emotional response of a model" (p. 4).

Vicarious processes have been used as explanatory concepts by investigators of observational learning. They are regarded as important phenomena because they describe how one individual is affected by another's emotions. The resultant behaviours of the observer may be classically conditioned to formerly neutral aspects of the situation. Vicarious instigation may also play a role in instrumental conditioning when the perception of a model's unconditioned emotional response leads to a vicariously instigated response in the observer, which in turn may result in reinforcement or punishment of the observer's prior behaviour. The unconditioned emotional response functions as an unconditioned stimulus to the observer (Green and Osborne, 1985). The modern idea of vicarious instigation was initially promoted by Berger (1962) as a conceptual framework for the study of empathy, envy and sadism, although the phenomenon of emotional response to the emotions of others had been considered by earlier investigators (Allport, 1924). According to Berger vicarious instigation occurs when an observer responds emotionally to a model's unconditioned emotional response as perceived by the observer. This means that the nature of the model's emotional response is not as important as the inference of it by the observer, as the actual state of the model is not directly observable. The inference on the part of the observer is drawn from the observable events and stimulus conditions in the environment; the model's UCS and UCR are important determinants of vicarious instigation. Thus the "meaning" (i.e. the perception) of the UCS to the observer may give

rise to vicarious instigation irrespective of the response of the model, for instance a mother's reaction to a falling child even though the child is unhurt and unstressed by the incident. Conversely, instigation may occur to the UCR of the model without the observer being aware of the UCS that gave rise to the response, for instance in the case of a mother hearing the child's cry while in another room and inferring the child's pain (UER) without knowledge of what caused it.

Berger (1962) distinguishes various phenomena which he refers to as pseudovicarious instigation. He stipulates that vicarious instigation is dependent on the inferring of the model's UER from either the UCS or the model's UCR. If the observer reacts independently and directly to the UCS, e.g., fear at the sound of a gunshot without knowledge of the nature of the target, or to the model's UCR without reference to the performer's UCS or UER. In this latter case Berger uses the example of a fear response elicited by a scream. This is an unfortunate example, for it is difficult to see how it might be distinguished in fact from the example of the child's cry quoted earlier. The only difference is in suggesting that the mother infers pain (UER) while in the scream example there is no inference of a UER on the part of the model. Such a distinction is dubious because inferences about the UER are not directly observable. It is difficult to imagine that a person or animal responding fearfully to a scream in another is <u>not</u> inferring fear or pain in the screamer unless

there is knowledge of the circumstances (UCS) under which it was emitted. Certainly, if someone reacted fearfully to a scream when the circumstances do not suggest fear on the part of the screamer, e.g., during a 1960s rock concert, then we might suspect that the scream itself is acting as a conditioned fear stimulus.

One of the studies cited by Berger as an instance of pseudovicarious instigation is the experiment by Church (1959) in which, following bar-press training on positive reinforcement schedules, rats were required to perform bar-pressing while another rat was shocked in an adjacent identical chamber. This produced suppression in bar-pressing, a measure of emotional response. This initial response soon adapted. Subjects were then divided into 3 groups. One group received emotional conditioning in a separate chamber in which shock was given to the experimental animal simultaneously with a model. In another group shock was given to subject and to a model but not simultaneously, and in a third group no emotional conditioning was given. In the fourth part of the experiment the suppressive effect on bar-pressing was tested by again shocking the model in the adjacent chamber. In the group that had received paired emotional conditioning the suppression effect was marked and only slowly abated. The group that had received no emotional training had showed no suppression, while the group that had received non-paired emotional conditioning initially showed suppression between that of the two other groups but soon recovered to baseline levels. Clearly,

there was an initial unconditioned emotional response by the experimental subjects to the emotional response of the models to the shock, but this habituated fairly quickly. This fitted the definition of vicarious instigation given by Berger. Following emotional conditioning the effect was re-instigated for both groups which had received shock and was enhanced for the group receiving paired shock during emotional conditioning. This latter enhancement may have been due to the further classically conditioned discriminated stimulus of the stressed model in the paired-shock group. This may have been the phenomenon of pseudovicarious instigation referred to by Berger but the total result cannot be interpreted in this way and the experiment illustrates the difficulty in attempting to define vicarious instigation by exclusion. As suggested by Thelen and Rennie (1972) and Green and Osborne (1985) there are methodological problems stemming from Berger's conceptualisation for an investigator in excluding many nonvicarious effects to observe any residual vicarious effects, when residual vicarious effects apparently cannot be produced independently of nonvicarious effects. There is considerable danger of throwing the baby out with the bathwater in using Berger's approach.

Another of Berger's exclusions, namely observer responses due to expectations that the observer will be treated similarly to the model (e.g. shocked), has similar difficulties. Such expectations are not directly observable and cannot in practice be easily separated from the total model-observer interaction.

Other theorists have been less restrictive than Berger (1962) in their definition of vicarious instigation. For Bandura (1977) vicarious instigation is dependent on shared experiences resulting in affective cues with instigating value derived from their predictive value in anticipating outcomes for the observer. Vicarious instigation occurs through an intervening arousal process brought about by the perceived relevance of the observed consequences for the model to the observer and the generation of an emotional response in the observer (Green and Osborne, 1985). What is important about this view is that it highlights the informational (cue) function of vicarious interactions. Bandura (1977) suggests five alternative explanations for vicarious reinforcement effects:

(a) Information about appropriate behaviours and likely outcomes is provided by the model;

(b) Stimulus enhancement occurs by enabling observers to more readily identify the situations in which behaviour is more or less appropriate.

(c) Observation of consequences in others has incentive-motivational effects in the form of anticipation of the value of likely outcomes.

(d) Vicarious emotional-conditioning arousal effects from observation of the emotional experiences of others.

(e) Modification of model status occurs according to the frequency of reinforcement and higher status models

are emulated more than lower status models. This mechanism might more readily be applied to social species than non-social species.

The first three of these proposed mechanisms involve information transfer in the performer-model interaction: information about the response-outcome relationship (R-S); information about the important stimulus elements (S-R); and information about the relative value of outcomes.

Aronfreed (1969) has differentiated between empathy (affective experience elicited by cues of a corresponding affective state in the expressed behaviour of another), and vicarious experience (affective experience elicited by observation of the stimulus events which impinge on another) (Green and Osborne, 1985). Aronfreed's notion of vicarious instigation (as opposed to empathy) seems to also point towards the importance of the informational function, i.e., providing information about the stimulus characteristics of the particular environment in which behaviour is occurring.

Hygge (1976a) has put the major emphasis on information flow in vicarious processes. The unconditioned stimulus to the model or the model's unconditioned response convey information to the observer which perceives or infers the model's emotional response. Where these events carry no information for the observer vicarious instigation or reinforcement do not occur (Green and Osborne, 1985). However

Hygge (1976b) claims on the basis of his data that the information about the model's unconditioned stimulus is not essential to vicarious instigation, whereas information about the model's unconditioned response is necessary for instigation to occur. Further, he suggests that (a) it is not necessary for the observer to have experienced the unconditioned stimulus; (b) vicariously instigated responses do not increase if the observer reacts aversively to the model's stimulus but the model does not; and (c) it does not add to the strength of the vicarious responses if the observer himself reacts aversively to the model's unconditioned stimulus (Hygge, 1976b).

The important factor in vicarious instigation seems to be the observer's perception of the model's behaviour in response to the unconditioned stimulus and not (a) the unconditioned stimulus; (b) the observer's response to the unconditioned stimulus; or (c) the observer's previous experience with the unconditioned stimulus. In an aversive situation (such as used by Hygge, 1976b) we would not necessarily expect that previous experience would be required as it is probable that the reaction to aversiveness has been programmed in evolutionary development, i.e. the response is in the shared species experience category, if not in the learning history of the individual. Thus, the suggested shared experience, as required by Bandura (1972) to give cue value to the model's responses for the observer, may still be necessary whether by evolutionary preparation or in the individual's learning experience.

The common thread running through the notions of social facilitation and vicarious instigation is the importance of the information or cues that the observer derives from the situation of the model, principally the behaviour of the model and the inferred emotional response. There may be a concommitant increase in the arousal and an emotional response on the part of the observer, but whether this is a mechanism which by itself fully explains behaviour changes in the observer is in doubt.

CHAPTER 3

OTHER ANIMAL EFFECTS IN AVOIDANCE

THE PRESENT INVESTIGATION

As Galef (1976) suggests there is a tendency on the part of investigators interested in animal interactions to be satisfied with an analysis of a behavioural social interaction that ends rather than begins with the discovery that there are changes in behaviour as a result of the interaction. Describing the interaction with such terms as 'social facilitation', 'imitation' or 'vicarious instigation' seems to reduce the perceived need for further analysis of the underlying mediating mechanisms or determination of the necessary and sufficient conditions for its occurrence. The present investigation seeks to elucidate the mechanisms and necessary conditions that might account for the inhibitory effect described by Dua and Dobson (1974; 1975) of a stressed model animal in the safe chamber on the acquisition of the avoidance response in a one-way hurdle-jumping task.

In an aversive situation and where an animal is acquiring an avoidance response it is most likely to be maximally sensitive to stimuli which provide information about the safety or danger of various elements in its immediate environment. As argued in Chapter 1 other animals, and particularly conspecifics, are likely to be important sources of such information.

A substantial amount of evidence has now been accumulated on the effects of other animals in aversive situations. It is not intended here to give an exhaustive review of this evidence but only to discuss the various types of interactions which occur and give examples, particularly of effects on the acquisition and extinction of avoidance responses.

In the typical vicarious classical conditioning experiment a model receives aversive stimuli paired with a neutral stimulus, which leads to the conditioning of stress or emotional responses to the previously neutral stimulus. Following observation of a model's reaction to the conditioned stimulus, an observer shows emotional responses to the conditioned stimulus alone, even though it has not itself experienced the aversive stimulus (Bandura, 1971). Berger (1962) and Bandura and Rosenthal (1966) present evidence of vicarious classical conditioning of fear responses in humans, and Miller (1967) provides clear evidence of the phenomenon in non-human primates.

In rats, Church (1959) showed that there is a substantial initial suppression of appetitive responding (bar pressing) when a model is shocked in an adjacent chamber and before subjects receive fear conditioning, i.e., without themselves experiencing shock. This initial depression in the rate of responding adapts quickly, returning to baseline after 3 or 4 exposures to the stressed model. Following fear conditioning in which shock to the subject is paired with shock to the model the suppression is reinstated and it reduces only slowly. A group in which shock was administered to the model not paired with shock to the subject, showed considerable suppression. This was not as great, however, as in the paired-shock group, and it adapted more quickly to baseline. There are two important results here. First, subjects appeared to react to stress responses of other rats without themselves experiencing the stressor. Second, experience with the stressor strengthened the reaction, particularly if experienced simultaneously with the model. That is, the effect of stress responses in others was strengthened by being observed in a context in which the subject itself expected danger. The more identical the situation, including timing, the more responsive the subject is to stress in others. Another interesting result of this experiment was that contrary to expectation, no anticipatory fear was developed to two panel lights that signalled shock to the model (by 1 minute). This suggests that there was no vicarious conditioning to the neutral light stimulus. It appears that the panel lights were not used to signal shock

to the subject during the fear conditioning stage of the experiment and hence they would not form part of the context of safety or danger for the subject.

Lore, Blanc and Suedfeld (1971) showed that rats made fewer physical contacts with a candle flame and learned to avoid the flame faster after observing models learning to avoid contact with a similar flame in an adjacent compartment, when compared with control subjects that had observed the model which was unable to make contact with a flame. In a refinement of the same experiment carried out by Bunch and Zentall (1980), a third group was added in which observers' visual contact with the models' candle flame was occluded by a strategically placed strip of metal. This visual control group was not significantly different from the no-contact group and made significantly more contacts with the candle flame than the experimental group which had unimpaired sight of the models' flame. Bunch and Zentall interpret this result as indicating that in the rat imitative passive avoidance is not produced by non-specific fear cues (auditory, visual and olfactory) but rather by visual cues associated with contacting the aversive stimulus. Another possibility is, however, that because the model's candle flame is not seen at any time in the visual-control group, for the observer subject the sight of a candle flame does not form part of the stimulus context of the avoidance demonstration. In the context of its own avoidance trial the candle flame is a novel visual stimulus for the observer.

Facilitation of active avoidance by observation of a model learning the avoidance task has been successfully demonstrated in monkeys (Presley and Riopelle, 1959) and cats (John et al, 1968). In this type of experiment the observer appears to have full perceptual access to all the elements in the stimulus/reponse/outcome sequence. In an experiment with rats Del Russo (1975) sought to differentiate between whether observers of an observational active avoidance learning task were learning the correct response, or whether the cue function of the discriminative stimulus was being learned. He included a control group in which a model was observed performing the avoidance task (shuttle) without the presentation of the warning stimulus (tone). For another control group the stimulus was presented during the observation phase but no model performed the avoidance task. Neither the response control group nor the stimulus control group performed any better than the normal control which had observed no part of the stimulus/response/outcome sequence. Observers exposed to the full sequence (both with naive and experienced models) learned significantly better than did any of the control groups. Del Russo concluded that the relationship between the warning stimulus and the response (i.e., the cue function) was the important component of observational learning.

Working with monkeys in a sophisticated co-operative learning set-up in which trained subjects observed film and television images of trained models receiving avoidance lever pulling trials, Miller, Banks and Ogawa (1963) and Miller (1967) found

that changes in facial features were highly effective in communicatng fear between partners. The observing subjects showed avoidance responses and heart rate increases to the stimulus monkey's facial fear cues on the onset of the conditioned stimulus, even though the observer did not observe the conditioned stimulus. In this procedure the observers had all been trained on the avoidance task, so that although they did not have access to the conditioned stimuli during the test trials there would have been sufficient correlated background stimuli from the context of the experimental apparatus to cue fear-arousal and avoidance responding on observation of the stress cues from the model.

The effect of observation of classical aversive conditioning of a model rat on the ongoing active avoidance of the observer rat was studied in an experiment by Riess (1972). He showed that the rate of unsignalled shuttlebox avoidance responding was accelerated by presentation of a light which had been paired with shock to a model (the converse of suppression). Following sessions in which the model was not shocked after the light, the light presentations eventually failed to produce avoidance response increases in the observers, i.e. vicarious extinction. In the experimental procedure the subject was confined on a platform on one side of the shuttlebox while the classical conditioning of the model was carried out on the other side in clear view of the observer. Hence, the subject observed the conditioning of the model within the

context of the safe/dangerous environment and was also in a position to perceive the stimulus/outcome contingency related to the stimulus light which was shown to be necessary by Del Russo (1975).

A number of studies have shown the facilitatory effects of non-stressed models on the extinction of avoidance in humans (Bandura, Grusec and Menlove, 1967; Bandura and Menlove, 1968; Bandura, Blanchard and Ritter, 1969) and in rats (Marina and Bauermeister, 1974). Appetitive responses previously suppressed by aversive stimuli are reinstated when a non-stressed model is observed emitting the same response (Hake and Laws, 1967; Masserman, 1943).

In a series of experiments, Dua and Dobson (1974, 1975) approached the question of other animal effects in avoidance somewhat differently to the studies outlined above. In their paradigm the model did not undergo classical conditioning to a selected experimental stimulus, or required to learn or perform any passive or active avoidance response. Instead the model was simply shocked in a part of the experimental apparatus that had significance to the observer's learning of an active avoidance response (safe or goal chamber). Dua and Dobson were seeking to show that the stressed or fear olfactory cues left by the model in the safe chamber would retard acquisition and hasten extinction of avoidance. They argued that the presence of olfactory fear cues in the safe chamber would increase the similarity between it and the

start chamber leading to a decrease in reinforcement by lesser fear reduction (Miller, 1951) and/or a decrease in elicitation of relaxation responses in the safe chamber (Denny and Adelman, 1955).

Dua and Dobson (1974) studied the effect on avoidance acquisition and extinction of shocking a model animal in the safe chamber of a one-way hurdle-jumping set-up using albino rats. It was predicted that shocking a model in the safe chamber of the apparatus would lead to slower acquisition and faster extinction.

In the first experiment the model was shocked for 5 seconds, and left for a further 20 seconds behind an opaque door (olfactory group) or a transparent door (olfactory-visual group) immediately prior to the commencement of each avoidance acquisition trial while the test subject was in the start chamber. Two control groups were used. For one (olfactory control group) a model animal was placed in the safe chamber for the same time as the models in the experimental groups but was not shocked. In the second control (no-animal control group) no model was placed in the safe chamber, the normal avoidance acquisition task. The inter-trial interval and the time that the test subject spent in the start chamber prior to the onset of each trial was the same for the no-animal control groups as for the three model groups. All subjects had been housed in pairs prior to the experiment; one subject in each pair being designated the test subject and the other

the model. As predicted each of the experimental groups made significantly fewer avoidance responses than the two control groups. The olfactory and olfactory-visual experimental groups did not differ in the number of avoidance responses. It was concluded from this that the visual cues did not add to the olfactory cues produced by the shocked model. However, auditory cues (squealing and the sound of jumping) were not controlled for, so that the conclusion that it was olfactory cues that were primarily operative was not necessarily justified, although evidence (Marr and Gardiner, 1965) of the importance of olfactory cues in rat social interaction suggests that they probably were.

The avoidance extinction experiment was carried out using three groups: olfactory, olfactory control and no model animal control. An olfactory-visual group was not included in view of the lack of difference from the olfactory experimental group in the acquisition experiment. Subjects were given 50 normal avoidance acquisition trials during which no model was present. After initial training subjects were randomly assigned to one of the groups and testing proceeded in the same way as in the acquisition experiment with the model shocked or not shocked, or no model present in the safe chamber, according to the assigned group. However, in this experiment no shock was delivered to the test subject if it failed to make the avoidance response. Each subject received trials until it reached a criterion of no avoidance within

15 seconds for 5 consecutive trials. The results revealed that shocking the model in the safe chamber produced significantly faster extinction of the avoidance response. There was no significant difference between olfactory control and no model control groups.

Further experiments (Dua and Dobson, 1975) showed clear gradients in avoidance acquisition when different shock intensities and shock durations were used in shocking models in the safe chamber. The results of the shock intensity experiment are depicted in Figure 1. In groups where the model received shock at intensities of 40, 60 and 80 volts there were significantly fewer avoidance responses than for groups with the model receiving 0 (i.e. no shock) and 20 volts. The 80 volt group showed no significant learning by the end of 50 trials. In all groups the UCS for the test subject was 60 volts. The gradient of duration of shock to the model was less straightforward (Figure 2). Even short periods of shock to the model (0.5 sec.) initially depressed avoidance acquisition compared with no shock to the model. However, the two shortest shock duration groups (0.5 sec. and 2 sec.) recovered after about 30 trials, whereas in the longer shock groups (5 sec. and 10 sec.) avoidance acquisition continued to be depressed during the whole 50 trials. However, even the 10 sec. group had made significant learning by the end of the 50 trials, unlike the highest shock group in the previous experiment. In the shock duration experiment all shocked

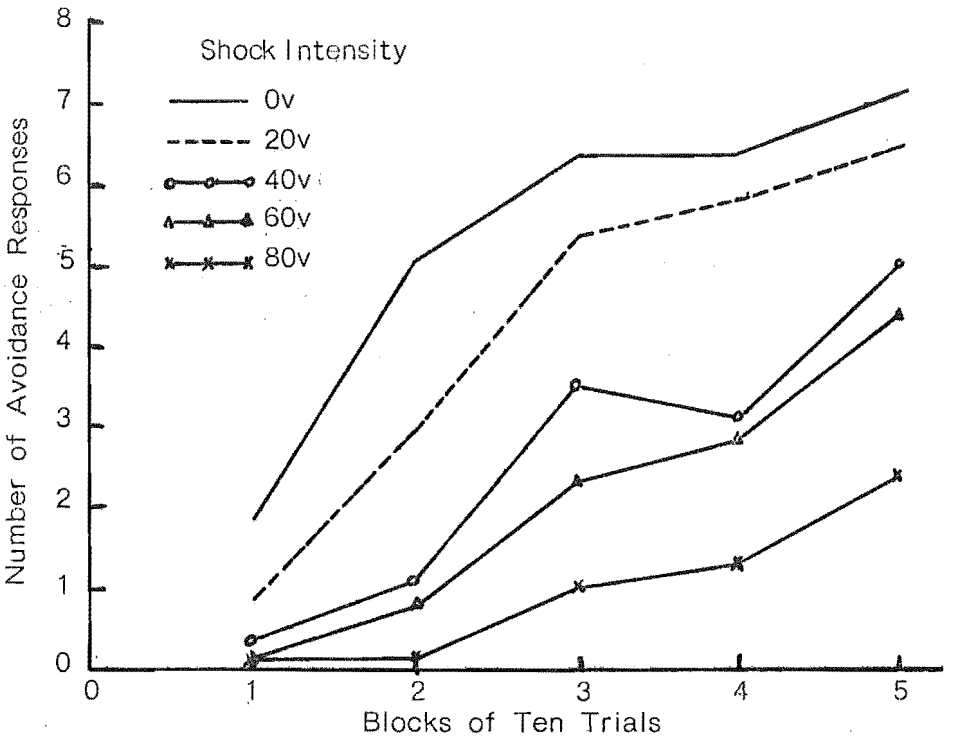

Figure 1. Avoidance acquisition as a function of shock intensity to model animals. (Dua and Dobson, 1975).

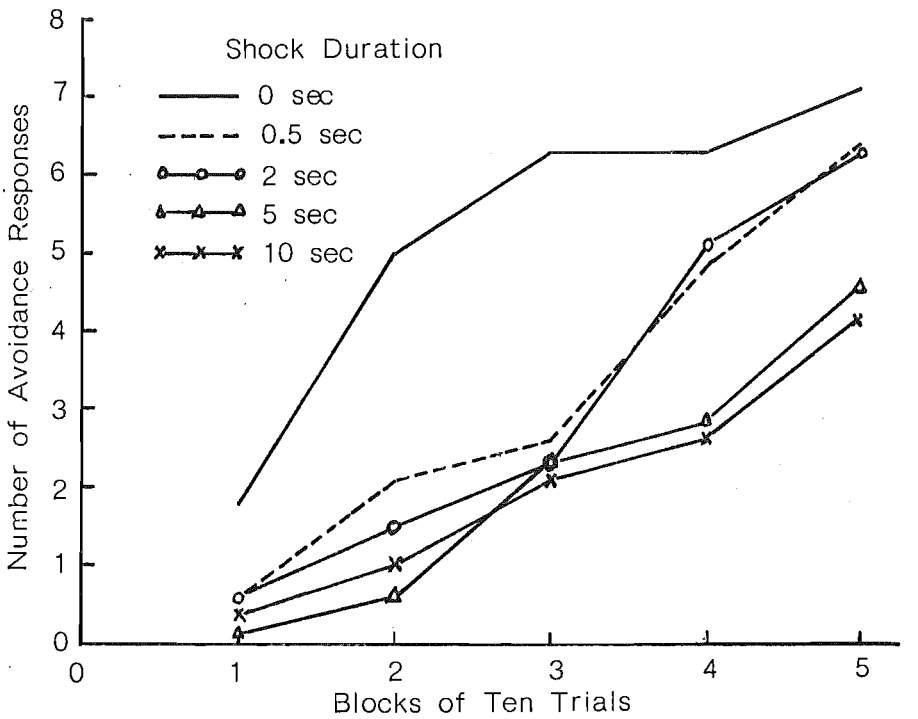

Figure 2. Avoidance acquisition as a function of shock duration to model animals. (Dua and Dobson, 1975)

models received the same intensity of shock (60 volts) and were in the safe chamber for identical periods of time (20 sec.).

The results of the gradients experiments showed clearly that the cues emitted by a shocked model animal are not identical under all circumstances, shock intensity being the most important differential cue. Clearly the observer receives different information about the state of the model under different conditions of shock level and shock duration. It is important to note that in this series of experiments cues about the stimulus/response/outcome contingencies or contextual cues about the safety/danger of environmental elements must have come from the perceived state of the model animal. There was no specific conditioned stimulus during the shocking of the model, other than those associated with the safe chamber, and the UCS to the model (shock) was not observable. It was assumed that for greater shock intensities and longer shock duration greater fear was conditioned to the safe chamber for the model, and hence stronger fear cues were available to the observer. A further assumption is that these fear cues of varying strength led to varying levels of vicariously conditioned fear to the safe chamber in the observer.

The present investigation was carried out to further investigate the phenomenon of disruption of avoidance acquisition in an observer as a result of the shocking of a model animal in the safe chamber of a hurdle-jumping apparatus (Dua and

Dobson, 1974, 1975). Three possible mechanisms that could account for this effect emerge from the studies reviewed above.

(1) Vicariously instigated or conditioned emotional states

The first possible mechanism is that an emotional state similar to that engendered in the stressed model is transmitted to the observer and is vicariously conditioned to the safe chamber. The cues which mediate this transmission may be olfactory, or they may be a generalised combination of olfactory, visual and auditory cues emitted by the model during and immediately following the shock in the safe chamber. The implication is that the stress cues become associated with the safe chamber itself and increase its similarity with the start chamber. An alternative variant of the vicariously instigated state hypothesis was suggested by Dua and Dobson (1975). During the experimental procedure the model receives inescapable shock and although it is not clearly unsignalled, as shock reliably follows the placing of the model in the apparatus, a state of learned helplessness (Seligman and Maier, 1967; Seligman, Maier and Solomon, 1971; Maier and Seligman, 1976) may be engendered in the model. If this was vicariously instigated in the observer then a similar decrement in avoidance to that described by Seligman and Maier might result. Two basic mechanisms have been hypothesised to account for the helplessness phenomenon: (a) exposure to inescapable shock leads to reduced activity which is not learned but is mediated by shock-produced neurochemical depletion; and (b) exposure

to inescapable shock produces an expectancy that behaviour is independent of shock onset or offset (Jackson, Alexander and Maier, 1980).

The aim of Experiment 1 was to address two vicarious conditioning hypotheses: (a) that fear or stress are vicariously conditioned to the safe chamber, consequent on the model being shocked there, leading to an increase in its similarity to the start chamber and a decrement in the acquisition of avoidance in the observer; or (b) that helplessness is vicariously instigated in the observer by the exposure to inescapable shock of the model. In order to differentiate between these two hypotheses the observer was placed in an adjacent observation chamber while the model was shocked in either the start chamber or the safe chamber. If the safe chamber is made more like the start chamber by the association of fear or stress cues with it, then the inhibitory effect should not be observed when the model is shocked in the start chamber. If, however, the helplessness hypothesis is to be preferred then the decrement of avoidance acquisition should occur when the model is shocked in either the safe or the start chamber.

A comparison of the results of Experiment 1 with those of Dua and Dobson (1974; 1975) suggested that the location of the observer might be important to its being affected by the shocking of the model in the safe chamber. Experiment

2 compared the effect of a stressed model in the safe chamber for groups in which the observer was located in the observation chamber against groups in which the observer was located in the start chamber.

(2) Increased fear arousal in the start chamber

The procedure of placing the observer in an observation chamber introduces another step, namely, handling the observer while moving it from the observation chamber to the start chamber following shocking of the model. Experiment 3 explored the influence of this extra handling on the inhibitory effect.

Miller's (1967) heart rate data shows that increased arousal occurs during observation of cues of fear or stress in models. Church's (1959) findings of initial suppression of appetitive responding before emotional conditioning of the subject also suggests this interpretation. This, together with the results of Experiment 3 which suggested that handling may have an arousal reducing effect, led to an hypothesis that the increased arousal caused by the observation of stress in others adds to the already high arousal level in the aversive situation. This would produce the observed disruption of performance. It might be objected that Miller's monkeys showed an increase in avoidance, but in that case the avoidance response had already been learned, whereas here we are dealing with the acquisition of an avoidance response. As with Spence's generalised drive state notion, increased arousal facilitates a response when it is dominant but disrupts it when it is not.

If the shocking of the model with the subject in the start chamber simply increases arousal and thereby disrupts avoidance acquisition, then this should occur even if the model is shocked in another chamber outside of the context of the start/safe chambers. Experiment 4 was designed to produce evidence on this possibility by shocking the model in an adjacent neutral chamber prior to each avoidance acquisition trial while the subject is in the start chamber.

(3) Contextual or situational danger cues

One of the strongest threads running through the studies reviewed above is that the observer must have perceptual access to information about the stimulus/response/outcome context i.e., contextual safety/danger cues. In a hurdle-jump or shuttlebox avoidance task the subject is required to move from one part of the apparatus to another, i.e., it is required to change the spatial arrangement of elements in relation to itself. Manipulating of characteristics of various spatially distributed elements produces differences in the acquisition of the avoidance response. Avoidance acquisition is modified by making the various parts of the apparatus distinctive. For instance, one way and jump-out avoidance are facilitated (Knapp, 1965; Reynierse and Rizley, 1970) and two-way shuttlebox avoidance is inhibited (Moot, Nelson and Bolles, 1974) by making the safe and dangerous parts of the apparatus distinctive.

If a stressed model provided information on the situational danger cues within the context of the experimental environment, then in a hurdle-jump avoidance task this may very well be spatial information. A hint is provided by the results of Experiment 4 that direction might be a relevant variable. Experiment 5 explored directional cues as an important element of spatial organisation vis a vis the subject.

Directional cues would also be operational in two-way avoidance if they provide important information for subjects about the safety/danger characteristics of the environment. Thus we would expect the inhibitory effect of shocking a model in the "safe chamber" also to occur in shuttle avoidance. This would not be predicted by an hypothesis that shocking a model in the safe chamber increases the similarity with the start chamber, for, as mentioned above, it is the opposite procedure of making the chambers more distinctive that inhibits two-way avoidance (Moot, Nelson and Bolles, 1974). Experiment 6 assessed whether or not the inhibitory effect occurs in a two-way shuttle avoidance set-up.

CHAPTER 4

THE EXPERIMENTS

EXPERIMENT 1

Experiment 1 is designed to test whether the inhibitory effect on avoidance acquisition of shocking a model animal in the safe chamber (Dua and Dobson, 1974, 1975) might be accounted for by a helplessness cue hypothesis or a fear cue hypothesis. Dua and Dobson (1975) observed that there is a similarity between the inhibitory effect they found and that produced in a learned helplessness situation (Seligman and Maier, 1967). They suggested that, because the model animal was given inescapable shock, then the cues provided to the test animal may possibly signal helplessness. Another possibility is that because the observer is confined, its behaviour can have no influence on the stimulus (i.e. the stress cues from the model), so that this might induce a helplesness response. If the observer's response to the cues was to tend to be "helpless" then the observed disruption of avoidance learning would occur. Further, the disruption would occur equally, or even

more strongly, if the model is shocked in the start chamber, since the helplessness would be associated with the start chamber situation. On the other hand, if the cues being communicated are fear or stress cues which are associated with the safe chamber, and hence increase the similarity with the start chamber as suggested by Dua and Dobson (1974), then the inhibitory effect would not be observed where the model animal is shocked in the start. Indeed it might be expected that shocking the model in the start chamber would increase the strength of the fear or stress cues in the start chamber and produce a facilitatory effect on the acquisition of the avoidance response. By placing the test animal outside the experimental chambers in an adjacent observation chamber it was possible to compare the effect of the model shocked in the safe chamber with the model shocked in the start chamber.

In this experiment the test animal was placed in a neutral observation chamber adjacent to the experimental start and safe chambers of a one-way avoidance apparatus during the observation period. Five groups of subjects were run: in one group the model subject was shocked in the goal chamber before each avoidance trial, in a second the model was shocked in the start chamber, in the third and fourth groups the model was placed in the safe or start chamber respectively but not shocked and in the fifth group no model animal was used.

A helplessness hypothesis led to the prediction that the two Model Shocked groups would both show inhibition of avoidance acquisition when compared with the two Model Not Shocked groups and the No Model group. An hypothesis that the fear or stress cues were provided by the model animal, thus increasing the similarity of safe box to start box, led to the prediction that the Model Shocked in Goal group would show significant inhibition of avoidance acquisition compared to all other groups. The Model Shocked in Start group would not show a similar deficit and may even show enhanced performance.

METHOD

Subjects

The subjects were 72 male Wistar random derived albino rats. At the time of testing subjects were aged 70-90 days. Subjects were housed four to a cage from weaning at 21 days with ad-lib food and water. In addition to preweaning handling, they were handled for about 3 minutes each day for 7 days immediately prior to testing.

Subjects were assigned to groups as either test subjects (S_T) or model subjects (S_M), such a manner to ensure that each S_T came from the same cage as its corresponding S_M. S_Ts in the No Model Control group had no S_Ms assigned but had been caged with three other rats in cages of four animals.

Apparatus

The apparatus was a one-way avoidance hurdle-jump set-up consisting of two identical chambers each 275mm long by 180mm wide and 190mm in height, painted white, and covered by clear perspex covers. The compartments were separated by a dividing wall with a 70mm x 80mm guillotine door through which the animal was required to jump, 70mm above the chamber floor. Adjoining the experimental chambers and running the full length of them was an observation chamber. This was separated from the experimental chambers by a steel grill which was designed to allow the free flow of olfactory, visual and auditory cues. All chambers had grid floors for the delivery of shock to the feet of the subjects. The steel grill between the experimental and observation chambers was also electrified to discourage subjects from perching away from the floor grids. The observation chamber was not electrified.

The conditioned stimulus (CS) was a 2250 Hz tone of 80 db (measured in chambers) against a background level (produced by air conditioning) of 40 db. The unconditioned stimulus (UCS) was a 1.0 mA scrambled shock delivered to the subjects' feet. The US-UCS interval was 5 seconds. An initiate switch and a timer which turned on the UCS after 5 sec. (CS-UCS interval). The CS, UCS and response latency clock remained on until cancelled manually when the S_T made the required

response. For an avoidance response the CS was cancelled and the UCS not presented. A second circuit was set to deliver a 5 sec. 1.0 mA scrambled shock to S_Ms.

Procedure

S_Ts were assigned to five groups of 8 subjects each. For four groups, Model Shocked in Goal, Model Shocked in Start, Model Not Shocked in Goal and Model Not Shocked in Start, each S_T had an accompanying S_M. In the fifth group, No Model Control, there were no model animals. In each group half the S_Ts were required to jump from the left chamber to the right, and half from right to left.

Each S_T was habituated to the apparatus by being allowed 3 min. of free exploration of the start and goal chambers immediately before the start of the experiment. The door between the chambers was then closed and S_T placed in the observation chamber. For the Model Shocked groups S_M was then placed in either the start or goal chamber according to group and shocked for 5 sec. About 20 sec. later S_M was removed to a holding cage. S_T was put into the start chamber and the avoidance trial started. S_T was left in the safe chamber for 20-25 sec. before being returned to the observation chamber. This sequence was followed for each trial. In the case of the two Model Not Shocked groups, S_M was placed in the appropriate experimental chamber and left there for 25 sec. without shock prior to each S_T avoidance trial as before. In the No Model Control group the same sequence

was followed and S_T was moved to the observation chamber for the same period before each avoidance trial as for the other groups but no S_M was placed in the experimental chambers.

Each S_T was given 50 trials and the latency of the jumping response to CS recorded for each trial. If S_T had not responded after 30 sec. the trial was terminated and the next started. For avoidance responses the CS was terminated and UCS not presented on that trial.

The apparatus was thoroughly cleaned by washing with an antiseptic and deodorising solution following each subject's testing session.

RESULTS

The 50 trials were divided into five blocks of ten trials each and the number of avoidance responses determined in each block for each subject. The mean number of avoidance responses/block of ten trials for each of the five groups is shown in Table 1 and compared in Figure 3. A two-way analysis of variance with repeated measures on trial blocks (Winer, 1962) revealed no significant group or group x trial interaction effects ($F(4,35)=0.75$, $F(16,140)=0.54$ respectively) but there was a significant trial blocks effect ($F(4,140)=96.68$; $p<.001$) indicating significant learning for all groups (Table B1).[1]

---

1 Table numbers with the prefix B refer to tables in Appendix B.

Group	Trial Block 1	2	3	4	5
S_M shocked in start chamber	4.63	8.38	9.63	9.88	9.50
S_M not shocked in start chamber	3.75	8.25	8.75	8.75	9.00
S_M shocked in goal chamber	4.00	6.75	9.00	9.25	9.38
S_M not shocked in goal chamber	4.50	8.63	9.38	9.63	9.50
No S_M	4.38	7.88	8.63	9.75	9.38

Table 1. Mean number of avoidance responses/block of 10 trials (Experiment 1).

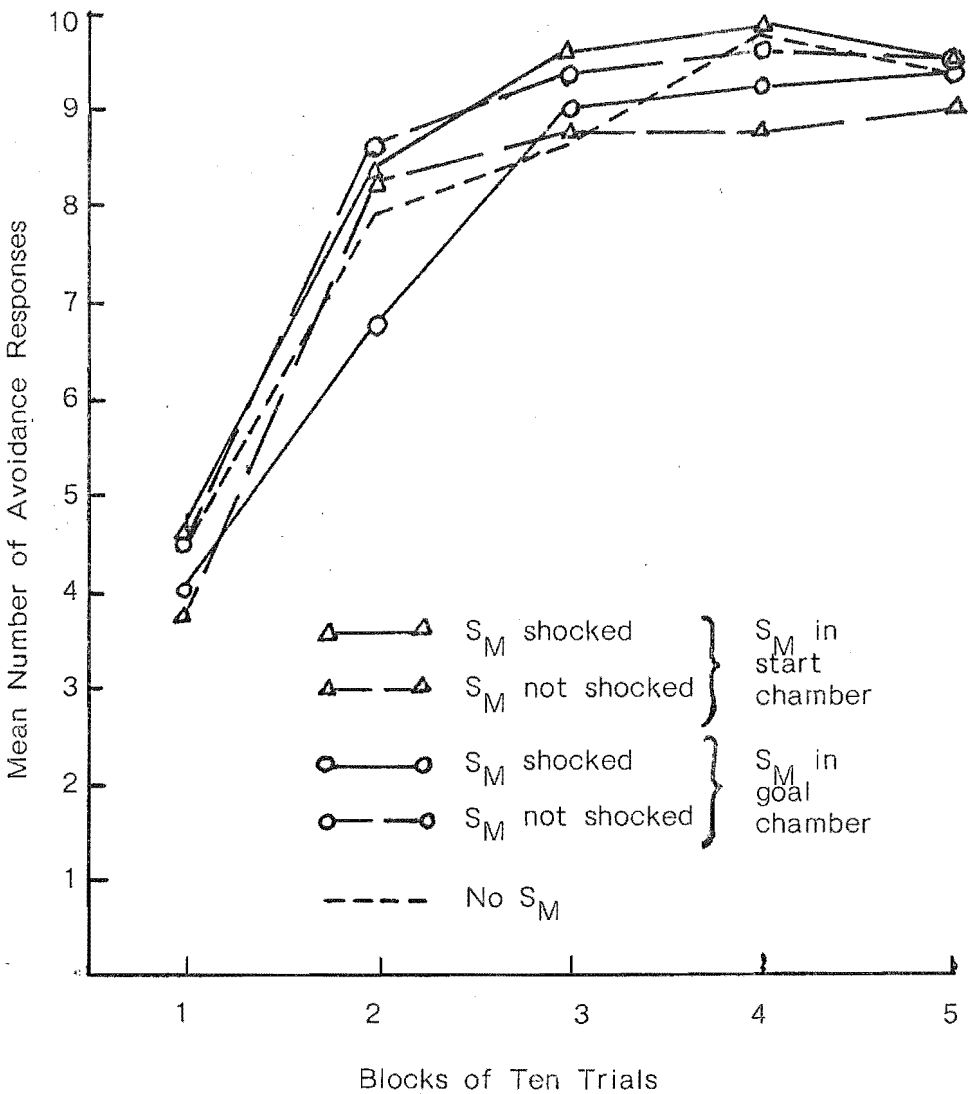

Figure 3. Comparison of avoidance acquisition for groups with model in goal and start chambers and no model control. (Experiment 1).

A range test (Kirk, 1968) indicated that latency data should be transformed using a log (x+1) transformation. The mean transformed latency was then calculated at each block of ten trials. A two-way analysis of variance of transformed latency data revealed that there was a significant reduction in response latency over trial blocks for all groups ($F(4,140)=105.95$; $p<.001$) but no significant differences between groups ($F(4,35)=2.05$) and no significant interaction effect ($F(16,140)=0.71$) (Table B2). Transformed latency data is shown in Table 2 and compared in Figure 4.

A further analysis of variance was carried out on both number of avoidance responses and transformed latency data for the groups in which there was a model subject. This allowed investigation of interaction between model condition (shocked/not shocked) and model location (start chamber/goal chamber) as factors. The third factor was repeated measures on trial blocks. This analysis revealed no significant model condition x model location interaction for the avoidance responses data although it approached significance ($F(1,28)=2.98$; $p<.10$) (Table B3), but there was a significant interaction for the latency data ($F(1,28)=5.40$; $p<.05$) (Table B4). Neither model condition x trial blocks nor model location x trial blocks interaction was significant for either number of avoidance responses ($F(4,112)=1.04$ and $F(4,112)=0.44$) or latency data ($F(4,112)=1.28$ and $F(4,112)=0$).

Group	Trial Block 1	2	3	4	5
S_M shocked in start chamber	0.71	0.45	0.27	0.31	0.32
S_M not shocked in start chamber	0.77	0.49	0.43	0.41	0.35
S_M shocked in goal chamber	0.78	0.55	0.40	0.39	0.36
S_M not shocked in goal chamber	0.74	0.45	0.41	0.38	0.36
No S_M	0.77	0.44	0.41	0.34	0.38

Table 2. Mean transformed response latencies (log (x+1)) (Experiment 1).

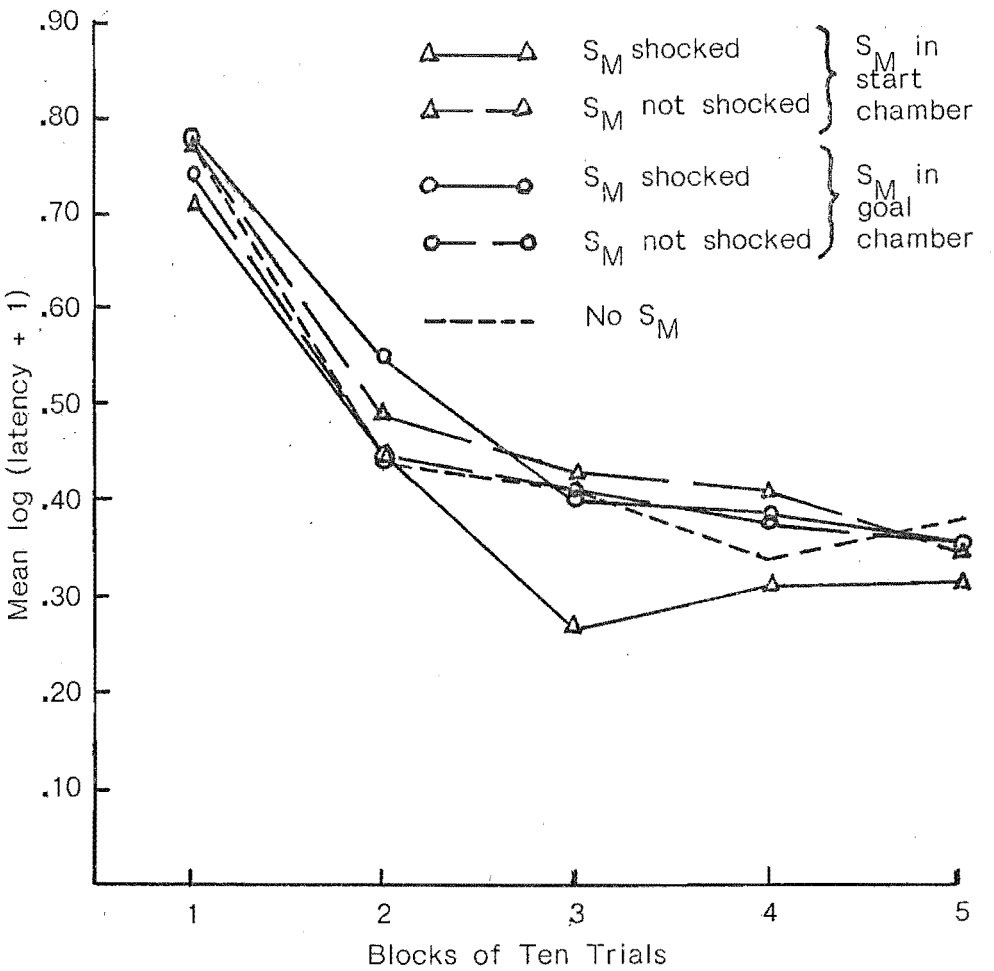

Figure 4. Transformed response latencies during avoidance acquisition. (Experiment 1).

Examination of the model location x model condition interaction profiles (Figure 5) for latency data indicates that shocking the model in the start box produced significantly lower response latencies than not shocking the model there ($F(1,28)=6.12$; $p<.05$). There was no significant difference between shocking and not shocking the model in the goal box.

DISCUSSION

Clearly neither of the predictions were confirmed as none of the five groups showed any deficit in the number of avoidance responses or any significant increase in response latencies. There was however, evidence that shocking the model animal in the start chamber produces a decrease in the response latency but no disruption of learning of the avoidance response.

The disruption of avoidance resulting from shocking the model animal in the safe chamber reported by Dua and Dobson (1974, 1975) did not occur in this experiment. However, the different procedure used, locating the test animal in a neutral observation chamber, may account for the different results. If this was so, it would seem that the cues provided by the model animal do not in themselves become attached to a particular place or chamber, except perhaps in the case where the model is shocked in the start chamber. In this latter case it may be that such cues are more compelling in the situation of immediate danger.

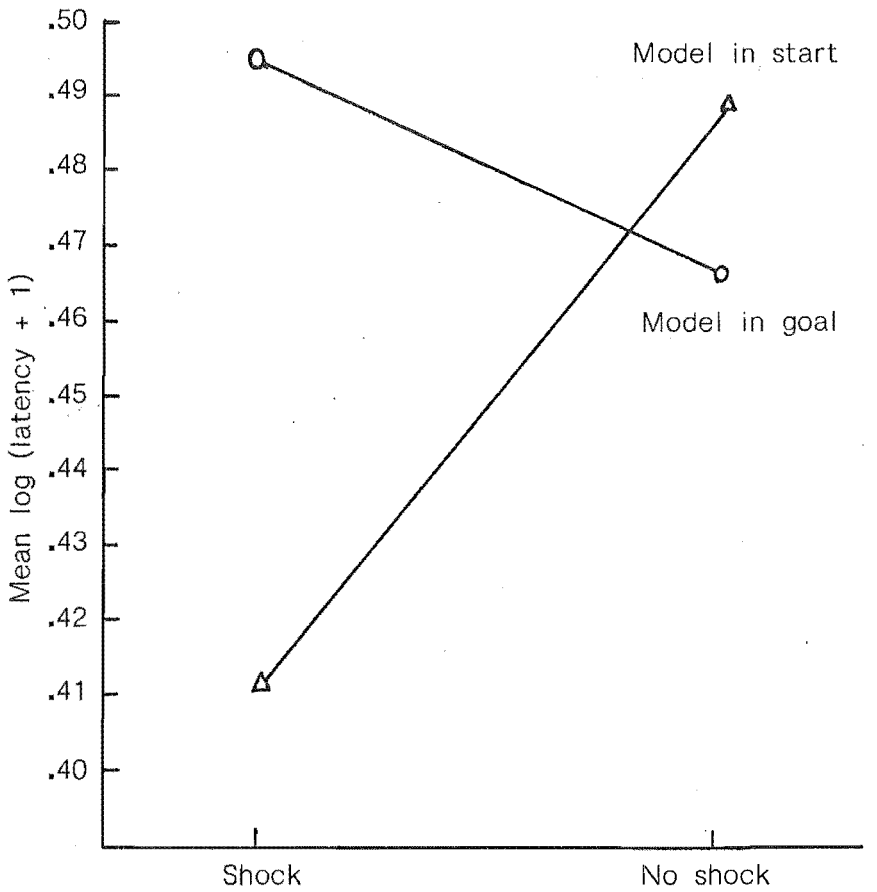

Figure 5. Profiles of model location x model condition interaction for transformed latency data. (Experiment 1).

These results are a little surprising in that evidence of odour trails and such results as that of King (1969) indicate that olfactory cues left by the same or another animal interact with physical place cues. In this experiment observers failed to show the disruption of avoidance acquisition described by Dua and Dobson (1974), despite having encountered cues (olfactory, visual and auditory) of the model being shocked in the safe chamber. It is possible that the location of the observer in the start chamber while the model is shocked may be a crucial factor in producing the inhibitory effect. Experiment 2 compared the effect of location of the observer in the observation chamber with location in the start chamber, the stressed model being in the safe chamber.

EXPERIMENT 2

This experiment was designed to provide a comparison of avoidance acquisition of observers located in the observation chamber with that of observers located in the start chamber (as in Dua and Dobson, 1974) during the shocking of the model in the safe chamber.

METHOD

Subjects

The subjects were 80 male Wistar random derived albino rats. At the time of testing subjects were aged 70-90 days. Subjects were managed and assigned as in Experiment 1.

Apparatus

As for Experiment 1.

Procedure

Groups in which the model (or no model) was in the safe chamber and S_T was in the observation chamber were the same as in Experiment 1. In order to study the effect of location of S_T during observation three groups were added in which S_T was placed directly back in the start chamber for the observation period prior to each avoidance trial. The six groups in this experiment were thus:

a) S_T in observation chamber while S_M shocked in safe chamber;

b) S_T in observation chamber while S_M present but not shocked in safe chamber;

c) S_T in observation chamber but no S_M used;

d) S_T in start chamber while S_M shocked in safe chamber;

e) S_T in start chamber while S_M present but not shocked in safe chamber;

f) S_T in start chamber but no S_M used.

There were 8 test subjects in each group, half of which were required to jump from the left chamber to the right and half from right to left.

Each S_T was habituated to the apparatus for 3 minutes immediately before the start of the experiment. The door between the chambers was then closed and S_T placed in the observation chamber or the start chamber according to group. For the four model groups, S_M was then placed in the goal chamber, shocked for 5 sec. and left for a further 20 sec., or left for 25 sec. without shock, according to group, and then removed to a holding cage. In the observation chamber groups, S_T was then moved to the start chamber, and the avoidance trial started. In the No Model groups the same sequences were followed but no S_M was placed in the goal chamber.

These sequences were repeated for each of 50 trials. The latency of the jumping response was recorded for each trial. If S_T had not responded after 30 sec. the trial was terminated and the next started. For avoidance responses the CS was terminated and UCS not presented on that trial.

The apparatus was thoroughly cleaned by washing with an antiseptic and deordorising solution following each subject's testing session.

RESULTS

The number of avoidance responses for each block of ten trials was determined for each subject. The mean number of avoidance responses/block of ten trials for each of the six groups is shown in Table 3 and compared in Figure 6. A three-way analysis of variance with repeated measures on trial blocks (Winer, 1962) indicated significant effects for S_T location ($F(1,42)=14.61$; $p<.001$) and S_M condition ($F(2,42)=8.09$; $p<.005$) (Table B5). The interaction between these two factors was significant ($F(2,42)=4.54$; $p<.05$). A significant effect is also revealed for trial blocks ($F(4,168)=116.21$; $p<.001$) and for the interaction between S_M condition and trial blocks ($F(8,168)=2.38$; $p<.05$). Neither S_T location x trial blocks nor S_T location x S_M condition x trial blocks interaction was significant (respectively $F(4,168)=0.95$ and $F(8,168)=1.19$).

Location of S_T	S_M Condition	Trial Block 1	2	3	4	5
S_T in start chamber	S_M shocked	1.25	2.50	5.75	6.50	7.00
	S_M not shocked	2.25	7.13	8.25	9.13	8.88
	No S_M	2.88	8.50	9.50	9.13	8.88
S_T in observation chamber	S_M shocked	4.00	6.75	9.00	9.25	9.38
	S_M not shocked	4.50	8.63	9.38	9.63	9.50
	No S_M	4.38	7.88	8.63	9.75	9.38

Table 3. Mean number of avoidance responses/block of 10 trials (Experiment 2).

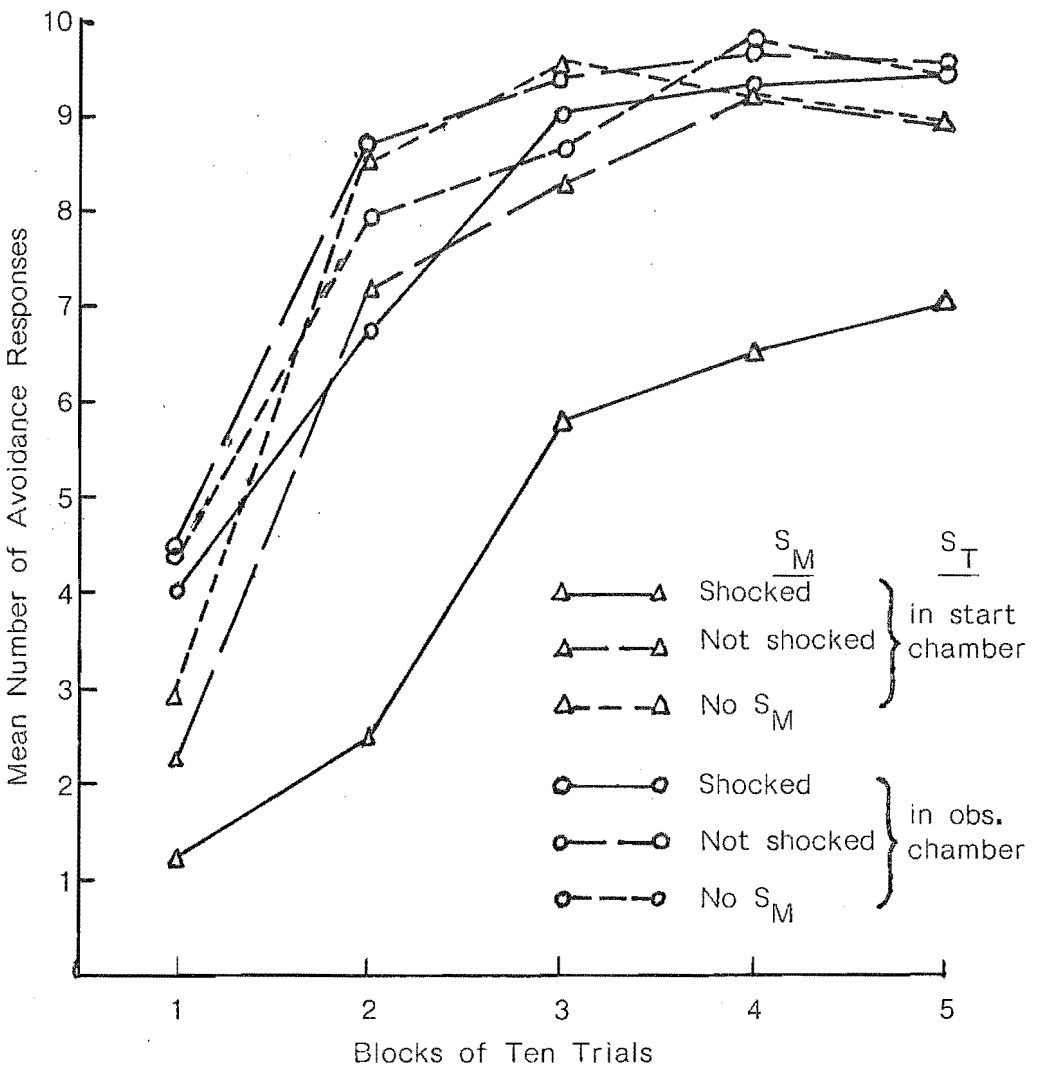

Figure 6. Comparison of avoidance acquisition for groups with S_T in start and observation chambers. (Experiment 2).

Analysis of transformed latency data (log (x+1)) revealed a similar pattern of significance (Table B6). Transformed latency data is shown in Table 4 and compared in Figure 7. Inspection of the data indicates that only the group in which S_M was shocked while S_T is in the start chamber showed impaired acquisition of the avoidance response.

DISCUSSION

The results for the three groups in which the test subject observed the model from the start chamber clearly replicated those obtained by Dua and Dobson (1974, 1975). They also support the view that the impairment in avoidance acquisition is dependent on the test subject being in the start chamer while the model subject is being shocked. It would seem, therefore, that any characteristics that might be given to the goal chamber by the shocked model are less important than the location of the test subject when the shocking of the model occurs, i.e., the test animal is in a dangerous situation. Rescorla and LoLordo (1965) found in studies of conditioned inhibition of avoidance with dogs, that to depress avoidance behaviour a stimulus must occur without shock against a background in which shock does in fact occur. Apparently to affect behaviour a stimulus must be relevant to the context in which the behaviour occurs.

The results obtained here tend to argue against an explanation of the deficit in avoidance acquisition in terms of a decrease

Location of S_T	S_M Condition	Trial Block 1	2	3	4	5
S_T in start chamber	S_M shocked	0.96	0.81	0.65	0.60	0.60
	S_M not shocked	0.86	0.55	0.44	0.40	0.43
	No S_M	0.85	0.45	0.38	0.36	0.38
S_T in observation chamber	S_M shocked	0.78	0.55	0.40	0.39	0.36
	S_M not shocked	0.74	0.45	0.41	0.38	0.36
	No S_M	0.77	0.44	0.41	0.34	0.38

Table 4. Mean transformed response latencies (log(x+1)) (Experiment 2).

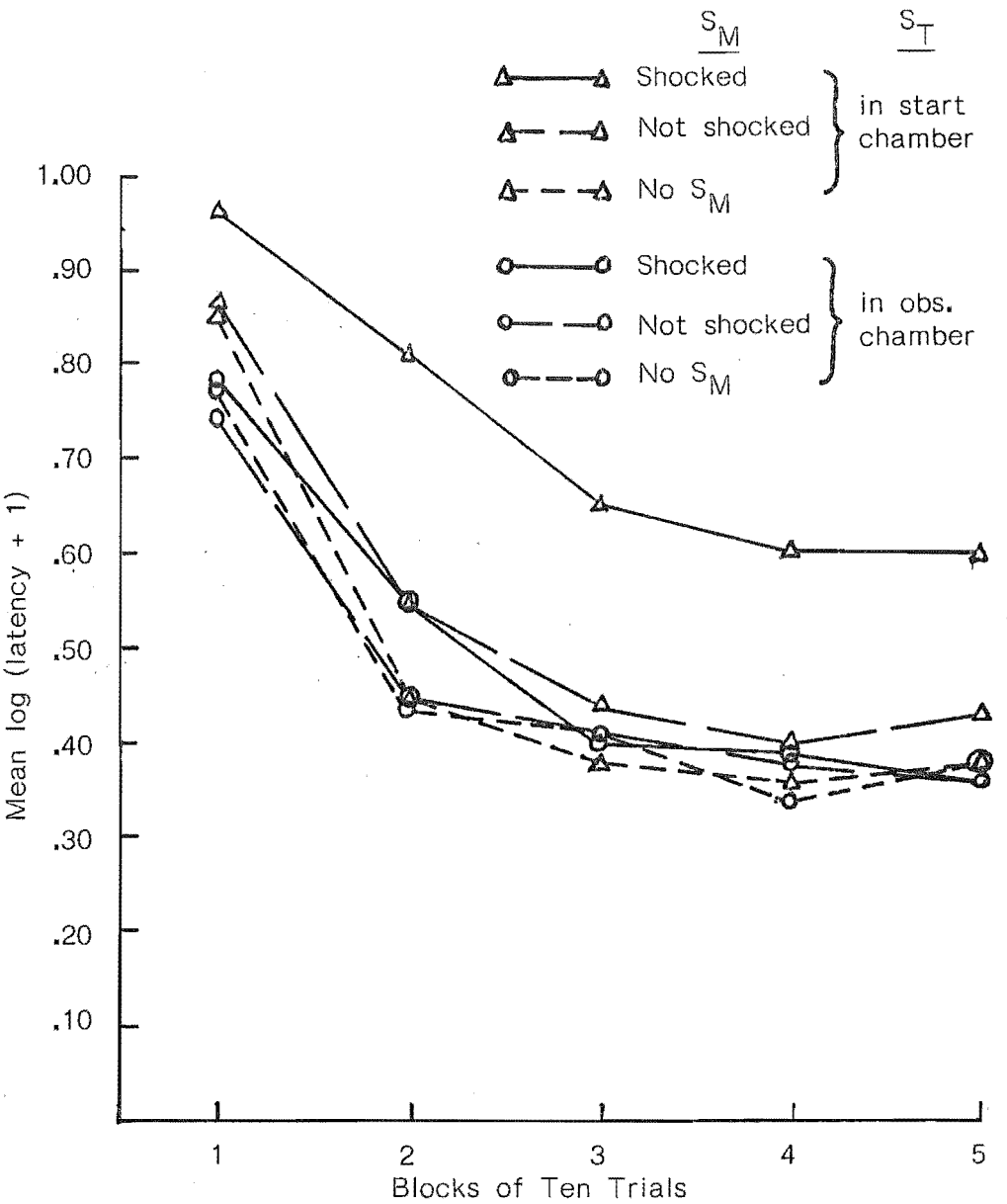

Figure 7. Transformed response latencies during avoidance acquisition. (Experiment 2).

in reinforcement based on characteristics of the safe chamber. A decrease in reinforcement might be said to stem from less fear reduction or relaxation occurring in the safe chamber, as a result of the stress or fear cues becoming associated with that chamber from the shocking of the model there. These cues could be received directly by the subject during the observation period or from residual olfactory material when the test subject enters the safe chamber after making a response. Either way it would be expected that shocking the model in the safe chamber would be equally effective whether the test subject was in the start chamber or the observation chamber. This is apparently not the case.

It might be objected that by placing the test subject outside of the safe/dangerous context during the observation period we are changing the reinforcement conditions by providing more fear reduction and/or relaxation, thereby producing faster acquisition than for those subjects that are returned to the start box for this period. This would counteract the effect of shocking the model when the test subject is in the observation chamber. Dua (1975) investigated the effect of different times in start box, safe box and a waiting cage on acquisition and extinction of avoidance. One condition held safe box times constant and varied start box and waiting cage times. This is analagous to the situation in the current experiment. Table 5 shows data taken from Dua (1975) and indicates that the longer the period spent outside the safe/dangerous context

Group	Start	Safe	Cage/Obs.	Mean trials to acquisition
1*	5 sec	20 sec	65 sec	127.0
2*	30 sec	20 sec	40 sec	90.0
3*	60 sec	20 sec	10 sec	62.0
Observation chamber groups	5 sec	20-25 sec	25 sec	Higher } Expected
Start chamber groups	30 sec	20-25 sec	0 sec	Lower }

Table 5. Comparison of location times and avoidance acquisition. Results obtained by Dua (1975) (marked *) with location times in current experiment.

and the less time spent in the start box, the slower the acquisition. This is compared with the times used in the current experiment.

The objection that the reinforcement is less for groups where the test subject spends time in the observation chamber cannot be sustained. If anything, Dua's (1975) data indicates the opposite. There is, however, no evidence of any difference in learning between groups with different test subject locations. Such a situation should have produced differences between the start chamber and observation chamber control groups and a significant S_T location x trial blocks interaction.

The present results appear to run contrary to previous findings which indicate that rats will respond to residual olfactory cues left by a shocked model. King (1969) found that after short post-conditioning periods (12 min.) residual olfactory material left by a conditioned substitute in a hurdle apparatus produced faster jump speeds in test animals than in subjects where no substitute odour cues were present. If the residual olfactory cues were operative in the present experiment, the effect of the shocked model should have been apparent in the groups where the test subject was in the observation chamber. Two possible explanations for the non-occurrence of the inhibiting effect could be: (a) the danger signals were only effective while S_T is in the start chamber. Residual olfactory cues may have been present but in the arrangement

used in this experiment were not compelling enough to produce the inhibitory effect; and (b) the danger signals lose their effectiveness when they occur in a situation where S_T is not in danger itself and/or relaxed. This reduction in effectiveness of the signals might then generalise to the dangerous situation and tend to render ineffective any residual olfactory cues that might become operative there.

The results of Experiment 1 that indicated that shocking the model in the start chamber while S_T was in the observation chamber produced a decrease in response latency was consistent with King's results and tends to support explanation (a) above. Residual olfactory cues were more compelling where they were in the start chamber.

It is possible that by handling the test subject between the observation of the model being shocked in the safe box and the beginning of the avoidance trial, (which is necessary when the test subject is moved from the observation chamber), the effectiveness of the danger cues may be disrupted. There is evidence that intertrial handling improves acquisition in two-way shuttle avoidance (Wahlsten and Sharp, 1969) and bar-press avoidance (Wahlsten et al., 1968). In both of these studies the data suggested that handling reduced freezing by the subject, thereby facilitating avoidance. If danger signals from the safe chamber tend to induce freezing in the current set-up, then the extra handling may tend to counteract this and lead to abolition of the inhibitory effect of shocking the model. Experiment 3 addresses this problem.

EXPERIMENT 3

Handling of the test subject between the observation of the model being shocked in the safe chamber and the start of the avoidance trial could be responsible for the abolition of the inhibitory effect on avoidance acquisition demonstrated by Dua and Dobson (1974, 1975). The placing of the test subject in the observation chamber requires such handling, which does not occur if the subject is returned directly to the start chamber for the observation period. It is possible that the stress cues provided by the shocked model induced freezing, but by interposing handling the freezing response was reduced or abolished. Hence, the inhibitory effect did not occur.

In this experiment test subjects were located in the start chamber for observation of the model being shocked, not shocked, or no model in the safe chamber, but following the observation period and prior to the beginning of the avoidance acquisition trial, the test subject was lifted out of the start chamber and then placed back there. The three groups thus treated were compared with three groups in which such handling was not interposed between observation and avoidance trial.

METHOD

Subjects

The subjects were 80 male Wistar random derived albino rats. At the time of testing subjects were aged 70-90 days. Subjects were managed and assigned as in Experiment 1.

Apparatus

The apparatus was as for Experiment 1 except that the steel grill between the observaton chamber and the experimental start and goal chambers was replaced by a solid wooden wall, painted white. This reduced the possibility of subjects being able to escape shock by hanging from the grill. A gap under the wall so formed was considered to be sufficient for the flow of olfactory visual and auditory cues. The observation chamber was not used in this experiment.

Procedure

Groups in which the test subject was not handled between the observation period and the start of the avoidance trial were the same as the three groups in Experiment 2 in which S_T was located in the start chamber during the observation period. Three groups were added in which S_Ts were also in the start chamber during the observation period but were picked up and placed back into the start chamber before the start of the avoidance trial. There were thus six groups in the experiment:

a) S_T in start chamber handled after observing S_M shocked in safe chamber;

b) S_T in start chamber handled after observing S_M not shocked in safe chamber;

c) S_T in start chamber handled after observing no S_M in safe chamber;

d) S_T in start chamber not handled after observing S_M shocked in safe chamber;

e)S_T in start chamber not handled after observing S_M not shocked in safe chamber;

f) S_T in start chamber not handled after observing no S_M in safe chamber.

In each group of test subjects half were required to jump from the left chamber to the right, and half from right to left. Each S_T was habituated to the apparatus by being allowed 3 min. of free exploration of the start and goal chambers immediately before the start of the experiment. The door between the chambers was then closed and S_T placed in the start chamber. For the four model groups, S_M was then placed in the goal chamber, shocked for 5 sec. and left for a further 20 sec., or left for 25 sec. without shock, according to group, and then removed to a holding cage. In the S_T Handled groups, S_T was picked up from the start chamber and immediately placed back there before the avoidance trial began. In the No Model groups the same sequences were followed but no S_M was placed in the goal chamber.

The same sequences were repeated for each of 50 trials. The latency of the jumping response was recorded for each trial. If S_T had not responded after 30 sec. the trial was terminated and the next started. For avoidance responses the CS was terminated and UCS not presented on that trial.

The apparatus was thoroughly cleaned by washing with an antiseptic and deodorizing solution following each subject's testing session.

RESULTS

The number of avoidance responses for each block of ten trials was determined for each subject. The mean number of avoidance responses/block of ten trials for each of the six groups is shown in Table 6 and compared in Figure 8. A three-way analysis of variance with repeated measures on trial blocks (Table B7) did not indicate a significant difference among groups for the main effect of handling ($F(1,42)=0.52$). However, there is a significant interaction between handling of S_T with condition of S_M ($F(2,42)=5.49$; $p<.01$). The main effects of S_M condition and trials blocks were both significant ($F(2,42)=3.23$; $p<.05$, and $F(4,168)=110.37$; $p<.001$ respectively) as was the S_T treatment x S_M condition x trial blocks interaction ($F(8,168)=4.52$; $p<.01$).

S_T Treatment	S_M Condition	Trial Block 1	2	3	4	5
S_T handled	S_M shocked	1.50	6.25	8.13	8.38	7.50
	S_M not shocked	3.50	4.25	6.63	8.38	9.25
	No S_M	2.25	4.00	6.50	7.63	8.25
S_T not handled	S_M shocked	1.25	2.50	5.75	6.50	7.00
	S_M not shocked	2.25	7.13	8.25	9.13	8.88
	No S_M	2.88	8.50	9.50	9.13	8.88

Table 6. Mean number avoidance responses/block of 10 trials (Experiment 3).

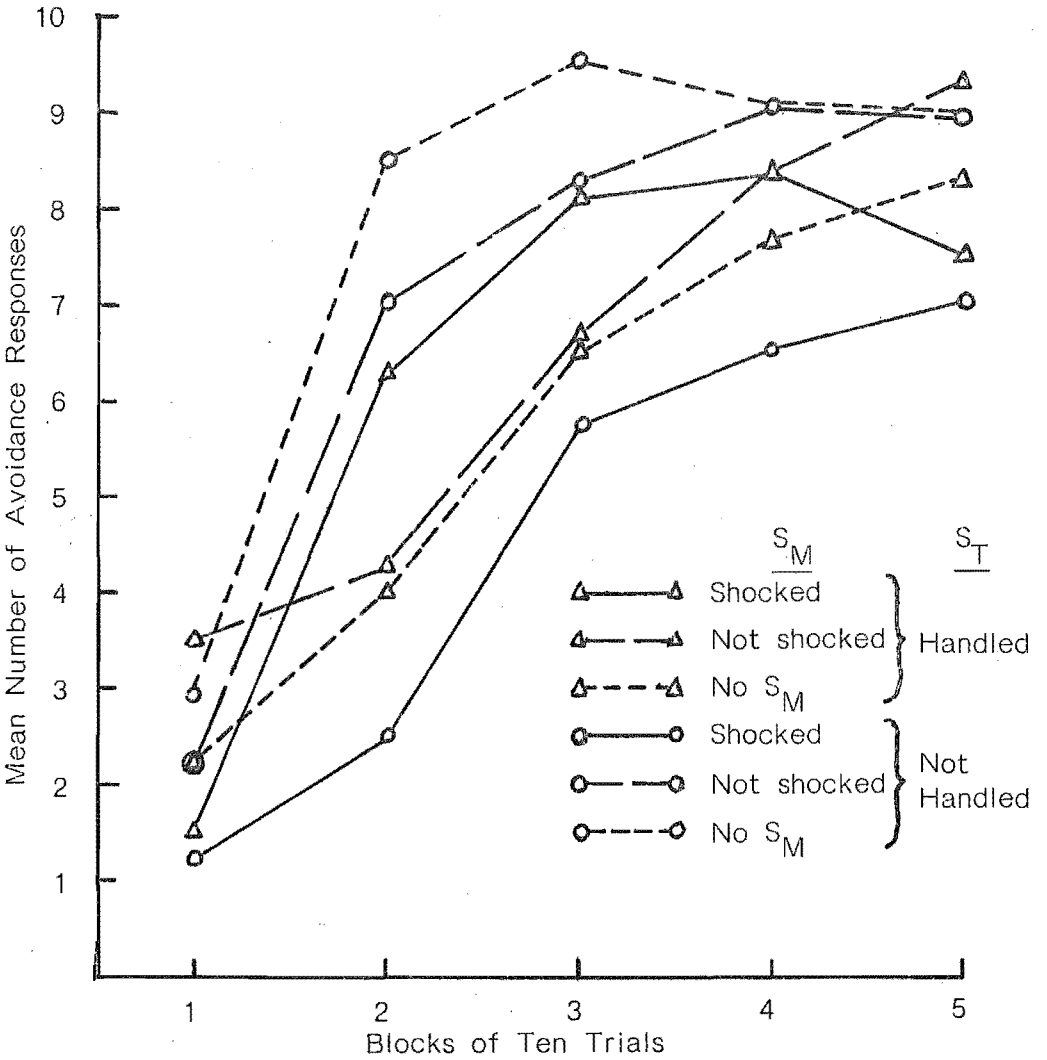

Figure 8. Comparison of avoidance acquisition for groups in which S_T was handled or not handled. (Experiment 3).

Investigation of the S_T treatment x S_M condition interaction shows that the effects of handling S_T after observing the model but before the avoidance trial were not straightforward. The profiles for this interaction are depicted in Figure 9. An examination of this and Figure 8 show that avoidance acquisition was enhanced when S_T was handled after observing a shocked S_M in the safe chamber, when compared with the shocked S_M group that was not handled ($F(1,42)=4.52$; $p<.05$). However, handling had little effect when the S_M was not shocked ($F(1,42)=0.78$), and depressed acquisition when compared to no handling when there was no S_M ($F(1,42)=6.20$; $p<.05$). In this latter case, the effect of handling was sufficient to make the mean total avoidance responses not significantly different from that of the group in which S_T was not handled after observing a shocked model ($F(1,42)=1.87$). However, there was no significant effects from S_M condition between the handled groups.

Transformed latency data for the six groups are shown in Table 7 and depicted in Figure 10. Analysis of variance indicated a similar pattern of significance as for the number of responses data (Table B8). The profiles for the S_T treatment x S_M condition interaction ($F(2,42)=7.40$; $p<.01$) are shown in Figure 11. Again there was a similar pattern with the effect of handling shortening response latencies for the S_M shocked group but increasing latencies for the No Model group when compared with the corresponding Not Handled groups

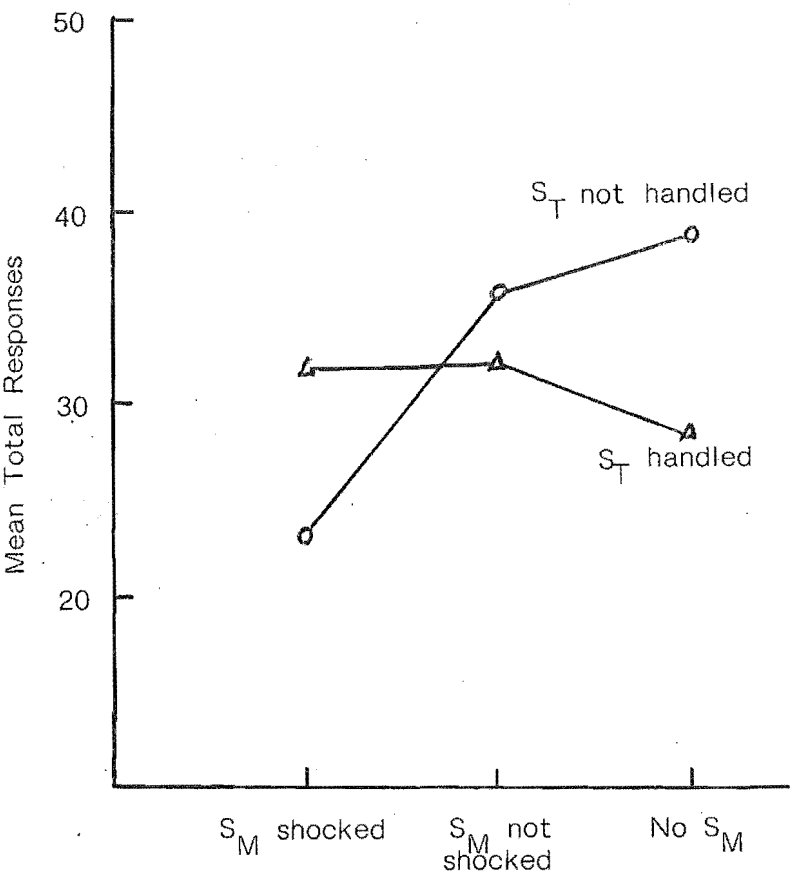

Figure 9. Profiles of S_T treatment x S_M condition for mean total avoidance responses. (Experiment 3).

S_T Treatment	S_M Condition	Trial Block 1	2	3	4	5
S_T handled	S_M shocked	0.89	0.59	0.47	0.44	0.48
	S_M not shocked	0.84	0.70	0.51	0.45	0.39
	No S_M	0.91	0.70	0.54	0.47	0.44
S_T not handled	S_M shocked	0.96	0.81	0.65	0.60	0.60
	S_M not shocked	0.86	0.55	0.44	0.40	0.43
	No S_M	0.85	0.45	0.38	0.36	0.38

Table 7. Mean transformed response latencies (log(x+1)) (Experiment 3).

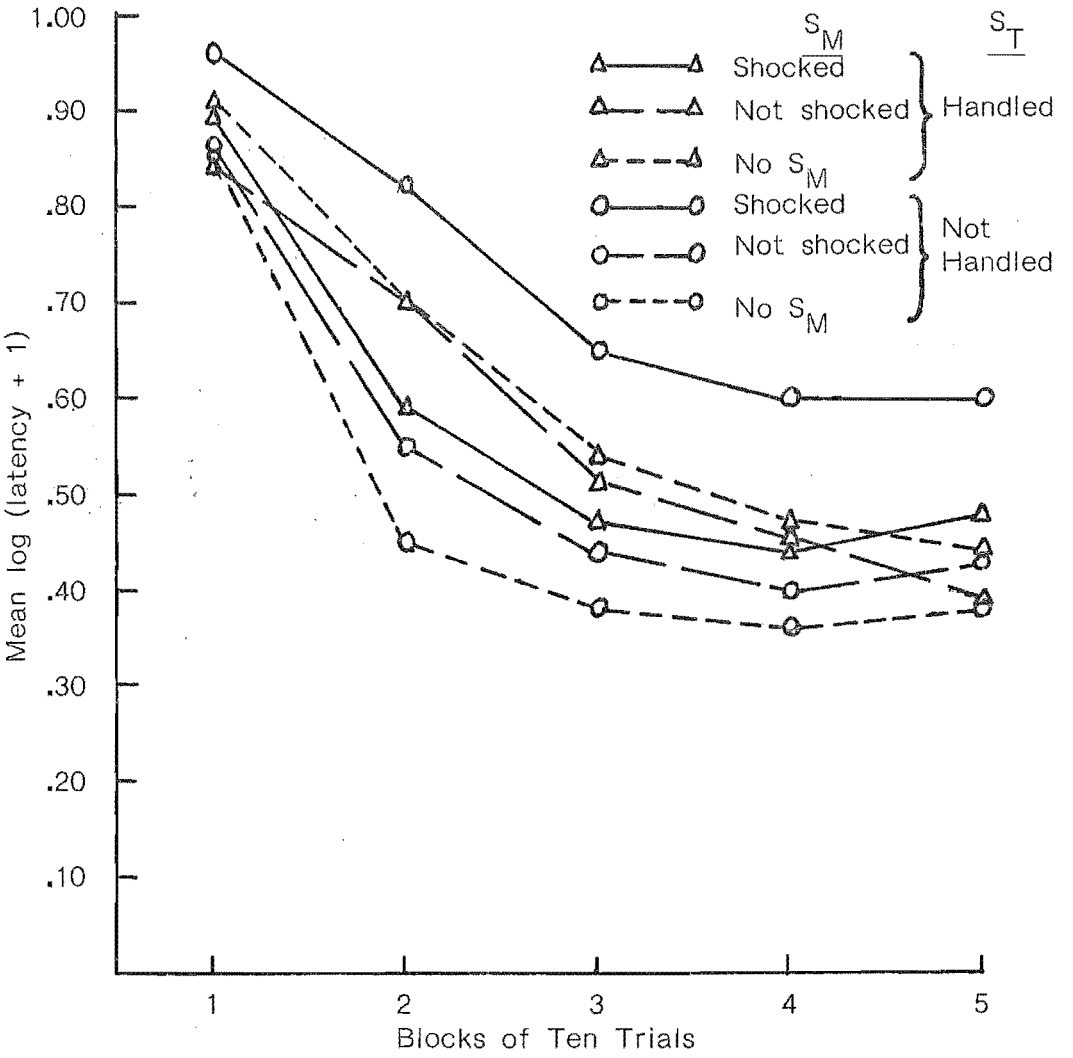

Figure 10. Transformed response latencies during avoidance acquisition. (Experiment 3).

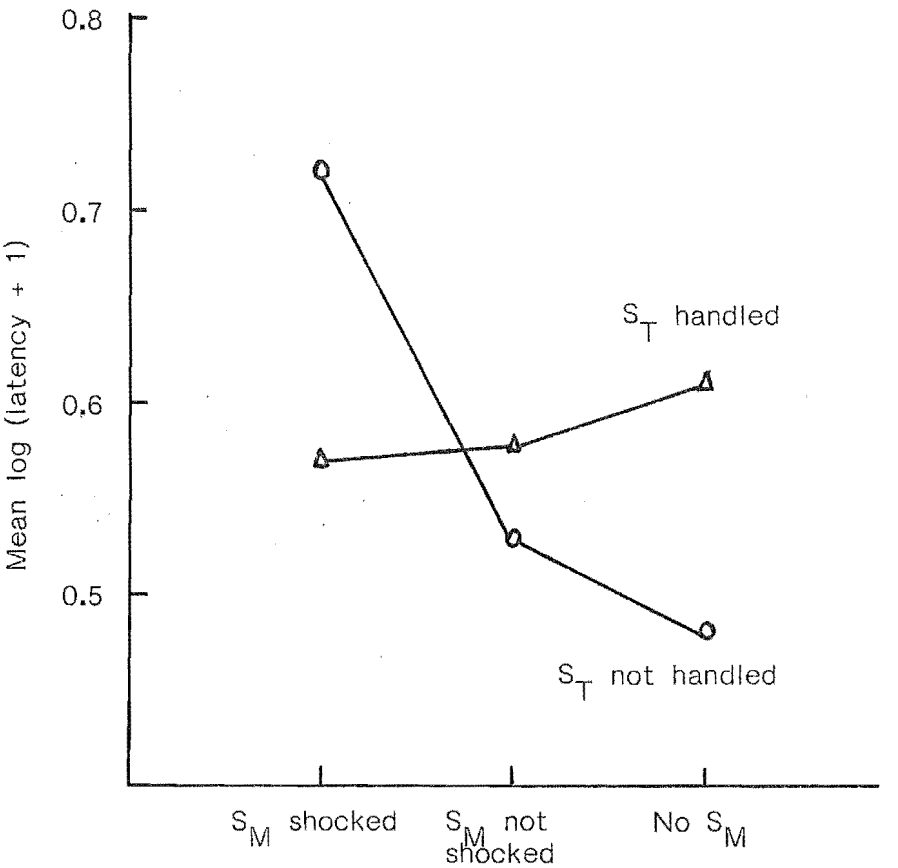

Figure 11. Profiles of S_T treatment x S_M condition interaction for transformed latency data. (Experiment 3).

($F(1,42)=8.58$; $p<.01$ and $F(1,42)=6.43$; $p<.05$, respectively). However, while the Handled, No S_M group did not make significantly more avoidance responses than the Not Handled, Shocked S_M group, its mean response latencies were significantly less than the Not Handled, Shocked S_M group ($F(1,42)=4.68$; $p<.05$). This suggests that although their avoidance responding was disrupted by handling they made escape responses more efficiently.

DISCUSSION

While the results suggest that handling the test subject between the observation period and the beginning of the avoidance trial affects the performance of the avoidance response, the effect is not simple and could not be said to fully account for the differences that occur between locating the test subject in the observation chamber and in the start chamber revealed in Experiment 2. Certainly handling improved performance after observing a shocked model in the safe chamber, but it appeared to make little difference after observing a model which was not shocked and inhibited performance when there was no model.

It is possible that fear reduction comes not from the handling itself but from the fact that the subject was taken from the start chamber, unlike the situation in Experiments 1 and 2, where the subject was taken from the observation chamber.

However, this could not explain the results for the observation chamber groups, since they were not removed from the start chamber. In any case, the handled groups showed a different pattern of responding among the Model Shocked, Model not Shocked and No Model conditions from that which occurred for the corresponding observation chamber groups, as a comparison of Figures 6 and 8 shows.

The evidence of Wahlsten and Sharp (1968) and Wahlsten et al. (1969) shows that handling appears to reduce freezing in an avoidance situation, which suggests a reduction in fear arousal level. The present results are consistent with this interpretation. In this series of experiments all subjects received a 7 day programme of daily handling by the experimenter in non-aversive circumstances, immediately prior to the testing session. It is thus reasonable to imagine that handling by the experimenter would develop some fear reducing and calming properties.

Suppose that there is a gradient of arousal or drive in observers in the start chamber which is correlated with the three conditions of the model, such that arousal is lowest when there is no model, intermediate when the model is not shocked, and highest when the model is shocked. If superimposing handling reduces drive levels in all three groups then the classic Yerkes-Dodson Law would predict the results of the current experiment. This can be achieved by shifting the

interaction profiles as demonstrated in Figure 12. However, to fully account for the effects of handling in this way it appears that the observer must be located in the start chamber.

This explanation for the effects of handling points to an hypothesis that the deficit in avoidance which results from the observation of a shocked model might simply be caused by an arousal increase, which adds to the already high arousal in the start box and detrimentally affects performance in line with the Yerkes-Dodson Law. If this is so then, while it is necessary for the observer to be in the start chamber, i.e., in a dangerous situation, it may not be necessary for the model to be in the safe chamber, i.e., the source of the arousal producing cues could be extraneous to the safe/danger context. Experiment 4 explored this possibility.

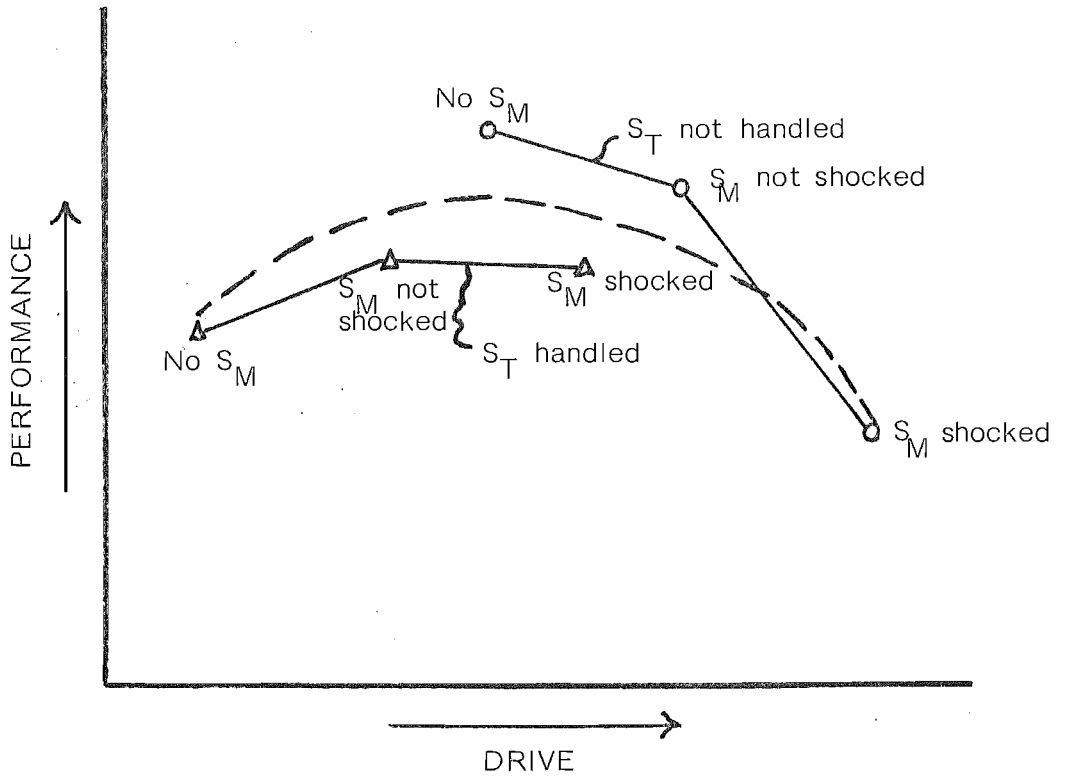

Figure 12. Demonstration of drive hypothesis on effects of handling by shifting interaction profiles of handling vs no handling.

EXPERIMENT 4

The results of Experiments 2 and 3 suggest that inhibition of avoidance acquisition might occur when the subject in the start chamber observes a model being shocked. It was argued that this may result from an increase in arousal or drive which, when added to the already high arousal caused by being in a dangerous situation, leads to a decrement in performance in line with the Yerkes-Dodson Law. Church (1959) has shown that shocking a model rat will produce suppression of ongoing appetitive responding, particularly when the subject has itself experienced shock. Response suppression of this type has usually been interpreted as evidence of an emotional response.

If the effect of observing a stressed model is simply to increase arousal, then it is possible that this would occur irrespective of the location of the model. The purpose of the present experiment was to test this by shocking the model in a neutral chamber outside the safe/dangerous context. The observation chamber was divided to provide two chambers to which shock was applied, one adjacent to the start chamber and one adjacent to the goal chamber. For one group the model was shocked adjacent to the goal while for another the model was shocked adjacent to the start. In two control groups the model was placed in these chambers without being shocked.

METHOD

Subjects

The subjects were 64 male Wistar random derived albino rats. At the time of testing subjects were aged 70-90 days. Subjects were managed and assigned as in previous experiments.

Apparatus

The apparatus was the same as that used in Experiment 3, except that the observation chamber was divided into two chambers and shock was applied to the grid floor in each chamber.

Procedure

The basic procedure was similar to that in previous experiments except that in this experiment the models were shocked (or not shocked) in a chamber adjacent to the goal or start chamber. Subjects were divided into 4 groups of 8 S_Ts and 8 S_Ms each. In two of the groups S_M was placed in the chamber adjacent to the start chamber where for one group S_M was shocked for 5 secs. and left for another 20 secs. during the intertrial interval as in the previous experiments and in the other group S_M was left in the chamber without shocking for the same period. For the other two groups the procedure was similar but the model was placed in the chamber adjacent to the goal chamber.

RESULTS

The mean number of avoidance responses/block of ten trials for each of the four groups is given in Table 8, and compared in Figure 13. Three-way analysis of variance with repeated measures on trial blocks (Winer, 1962) revealed a significant effect only for trial blocks ($F(4,112)=106.65$; $p<.001$) indicating that there was significant learning in all groups (Table B9). Neither location of S_M, condition of S_M nor any of the interactions were significant, although the S_M location x S_M condition interaction was approaching significance ($F(1,28)=3.33$; $p<.10$). Inspection of the interaction profiles reveal that for the no shock condition there were relatively more avoidance responses where the model was in the chamber adjacent to the goal.

Mean transformed response latencies are shown in Table 9 and Figure 14. Analysis of variance of these data reveal a significant S_M location x S_M condition x trial block interaction (Table B10). As with the number of avoidance responses data, the S_M location x S_M condition interaction approached significance ($F(1,28)=3.61$; $p<.10$).

Further investigation of the ABC interaction showed that for the no shock condition response latencies were significantly shorter in trial block 3 for the group where the model was

Location of S_M	S_M Condition	Trial Block 1	2	3	4	5
S_M adjacent start chamber	S_M shocked	2.63	8.25	8.75	8.75	9.13
	S_M not shocked	2.50	6.25	8.38	8.63	8.88
S_M adjacent goal chamber	S_M shocked	3.25	7.63	8.25	7.75	9.25
	S_M not shocked	4.00	7.75	9.75	9.75	9.38

Table 8. Mean number avoidance responses/block of 10 trials (Experiment 4).

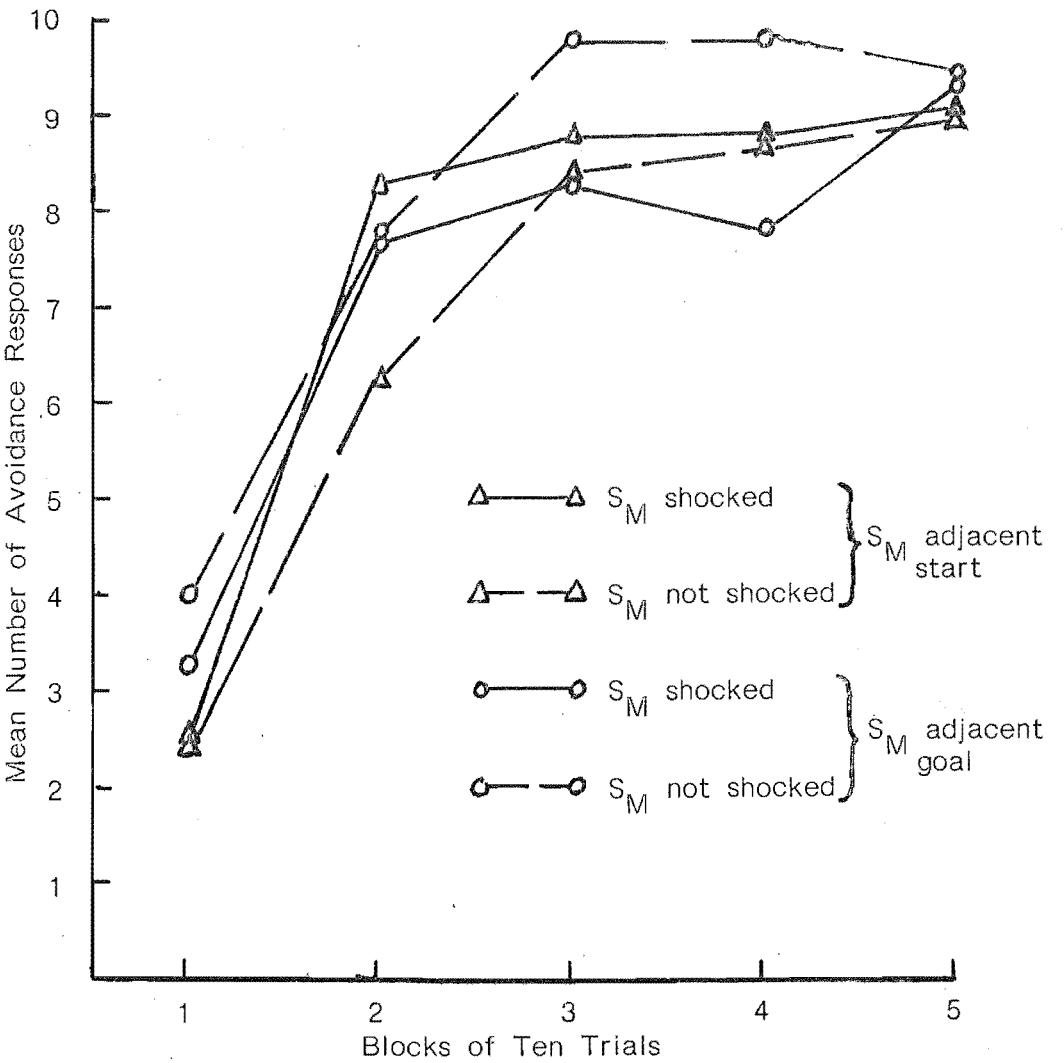

Figure 13. Comparison of avoidance acquisition for groups in which model was adjacent to start and goal chambers. (Experiment 4).

Location of S_M	S_M Condition	Trial Block 1	2	3	4	5
S_M adjacent start chamber	S_M shocked	0.82	0.49	0.42	0.44	0.42
	S_M not shocked	0.82	0.60	0.51	0.45	0.41
S_M adjacent goal chamber	S_M shocked	0.78	0.55	0.48	0.47	0.38
	S_M not shocked	0.73	0.49	0.34	0.39	0.39

Table 9. Mean transformed response latencies (log(x+1)) (Experiment 4).

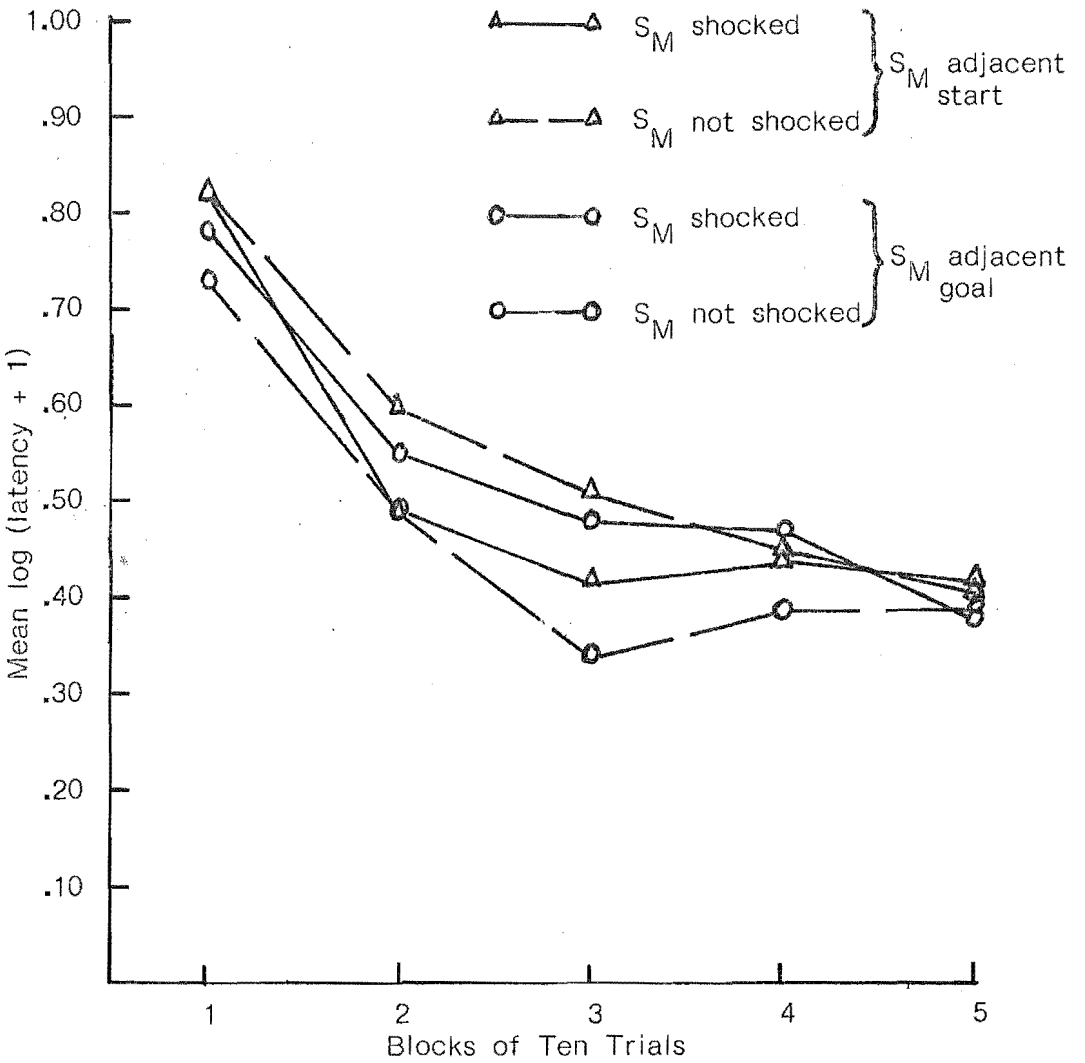

Figure 14. Transformed response latencies during avoidance acquisition. (Experiment 4).

placed in the chamber adjacent to the goal chamber than for the group where the model was adjacent to the start chamber ($F(1,20)=11.21$; $p<.01$). A similar difference in trial block 2 was very near significance ($F(1,20)=4.31$; $p<.10$).

DISCUSSION

The results did not support any explanation of the interference with avoidance acquisition by increased arousal or drive in the start chamber caused merely by the shocking of the model.

The shorter latencies for the group in which the model was adjacent to the goal chamber in the no shock condition may hint that there could have been some differential direction cues operating. Such directional cues could account for the non-occurrence of the inhibitory effect in earlier experiments when the test subject was located in the observation chamber for the observation period. Certainly there is some evidence that rats do use directional cues from extra-apparatus sources in one-way and shuttle avoidance (Lambert and Gorfein, 1958; Baum and Bobrow, 1966). It seems curious that if directional cues derived from the model were operating they were not effective in the case of the shocked models. However the evidence for directional cues from this experiment is weak, based only on a significant difference in response latencies in one trial block, a nearly significant difference on another block, and near significance of the S_M location x S_M condition

interactions for mean number of avoidance responses and response latencies.

Experiment 5 investigated whether or not there were any directional cues operative.

EXPERIMENT 5

There was a hint in the data from Experiment 4 that subjects might be using, at least in part, directional cues in their response to the stress in a model. If this is so, and coupled with the earlier evidence that the test subject needs to be located in the start chamber for the inhibitory effect on avoidance to occur, then it suggests that subjects make quite precise use of contextual information to determine the safety or danger of various elements of their immediate environment. This in turn influences the way in which they respond to the avoidance task.

By shocking the model in a third chamber in line with the safe chamber, Experiment 5 was designed to determine if there was any tendency for the subject not to move towards the shocked model. Such reluctance would be indicated if there were a disruption of avoidance acquisition and/or an increase in the response latencies.

METHOD

Subjects

The subjects were 40 male Wistar random derived albino rats. At the time of testing subjects were aged 70-100 days. Subjects were managed and assigned as in Experiment 1.

Apparatus

A detachable chamber identical in construction to the goal and start chambers was constructed. This was attached to the safe chamber on the end opposite to the door from the start chamber. A slit, about 2 cms wide and running the width of the chamber at grid floor level was cut in the ends of the experimental chambers to allow the free flow of cues between the third chamber and the safe chamber. When the experimental chamber was the start chamber the wall with the slit was covered by a solid sheet of hardboard, painted white, to form the end wall. Thus, attaching the detachable third chamber provided three chambers in a series. The subject was required to jump toward the direction of the model but not into the chamber where the model had been.

The peripheral equipment was the same as for previous experiments. The observation chamber was not used.

Procedure

The basic procedure was the same as in previous experiments except that the model received shock, or was placed without shock, in the third chamber attached to the end of the safe chamber. Subjects were divided into 3 groups of 8 test subjects. Two groups, Model Shocked and Model Not Shocked, had models assigned and the third group, No Model, had no models assigned.

RESULTS

The number of avoidance responses for each block of ten trials was determined for each subject. The mean number of avoidance responses/block of ten trials for each group is shown in Table 10 and compared in Figure 15. Analysis of variance (Table B11) revealed only a significant trial block effect ($F(4,84)=186.34$; $p<.001$) indicating significant learning in all groups, but no significant difference between groups ($F(2,21)=0.76$) or groups x blocks interaction ($F(8,84)=0.87$).

However, analysis of transformed latency data (Table B12) showed a significant difference between the groups for response latency ($F(2,21)=4.50$; $p<.05$). Inspection of the data (Table 11 and Figure 16) revealed that the Model Shocked group mades slower responses than both the Model Not Shocked group and No Model group. The trial block factor was significant ($F(4,84)=59.97$; $p<.001$) but there was no significant group x trial block interaction ($F(8,84)=1.14$).

These data suggest that while avoidance acquisition was not disrupted by shocking a model in a third chamber in line with the safe chamber, there was a reluctance to move towards the stressed model, indicated by significantly longer response latencies.

Group	Trial Block 1	2	3	4	5
Model Shocked	2.38	6.50	7.13	9.25	9.13
Model Not Shocked	2.25	7.00	9.00	9.00	9.75
No Model	3.13	6.63	9.00	8.88	9.25

Table 10. Mean number of avoidance responses/block of 10 trials. (Experiment 5).

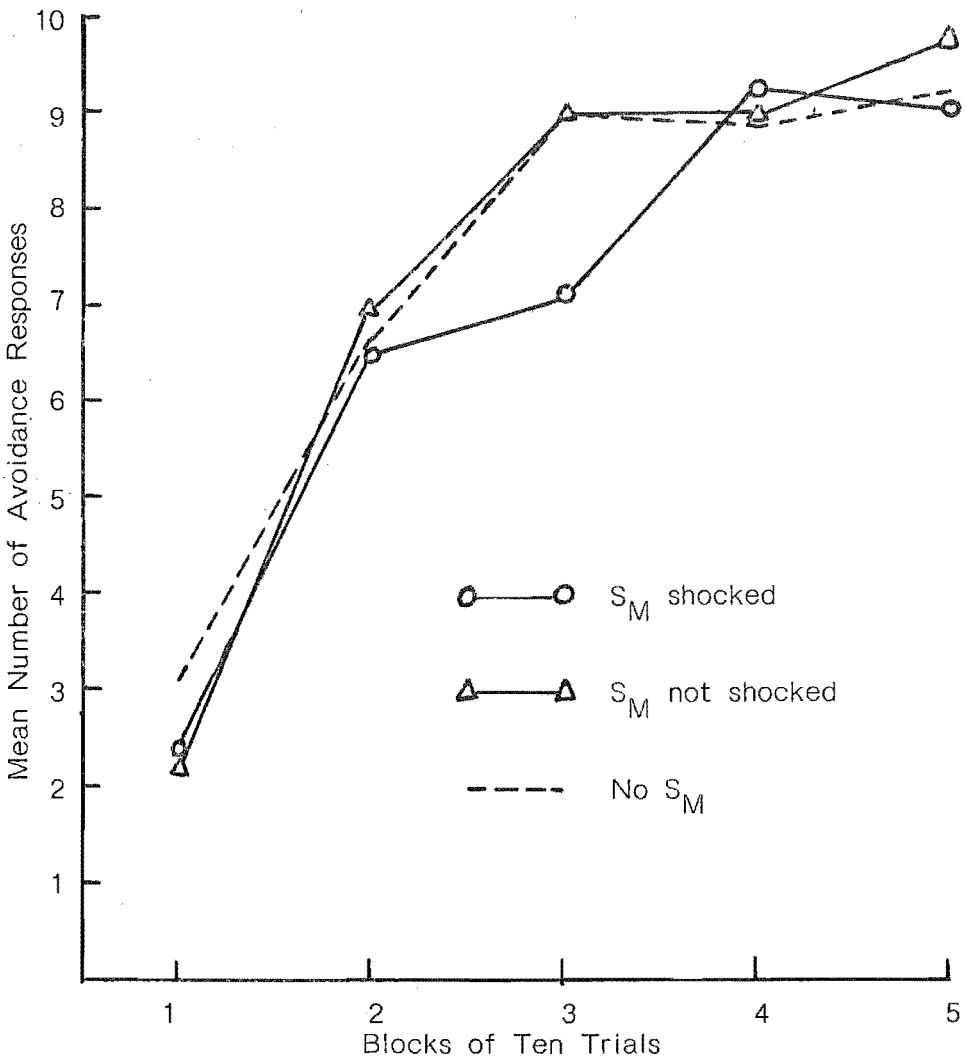

Figure 15. Comparison of avoidance acquisition for groups with model shocked or not shocked in a chamber in line with the safe chamber and no model control. (Experiment 5).

Group	Trial Block 1	2	3	4	5
Model Shocked	0.85	0.62	0.58	0.43	0.43
Model Not Shocked	0.80	0.52	0.37	0.35	0.32
No Model	0.79	0.55	0.36	0.38	0.38

Table 11. Mean transformed response latencies (log(x+1)). (Experiment 5).

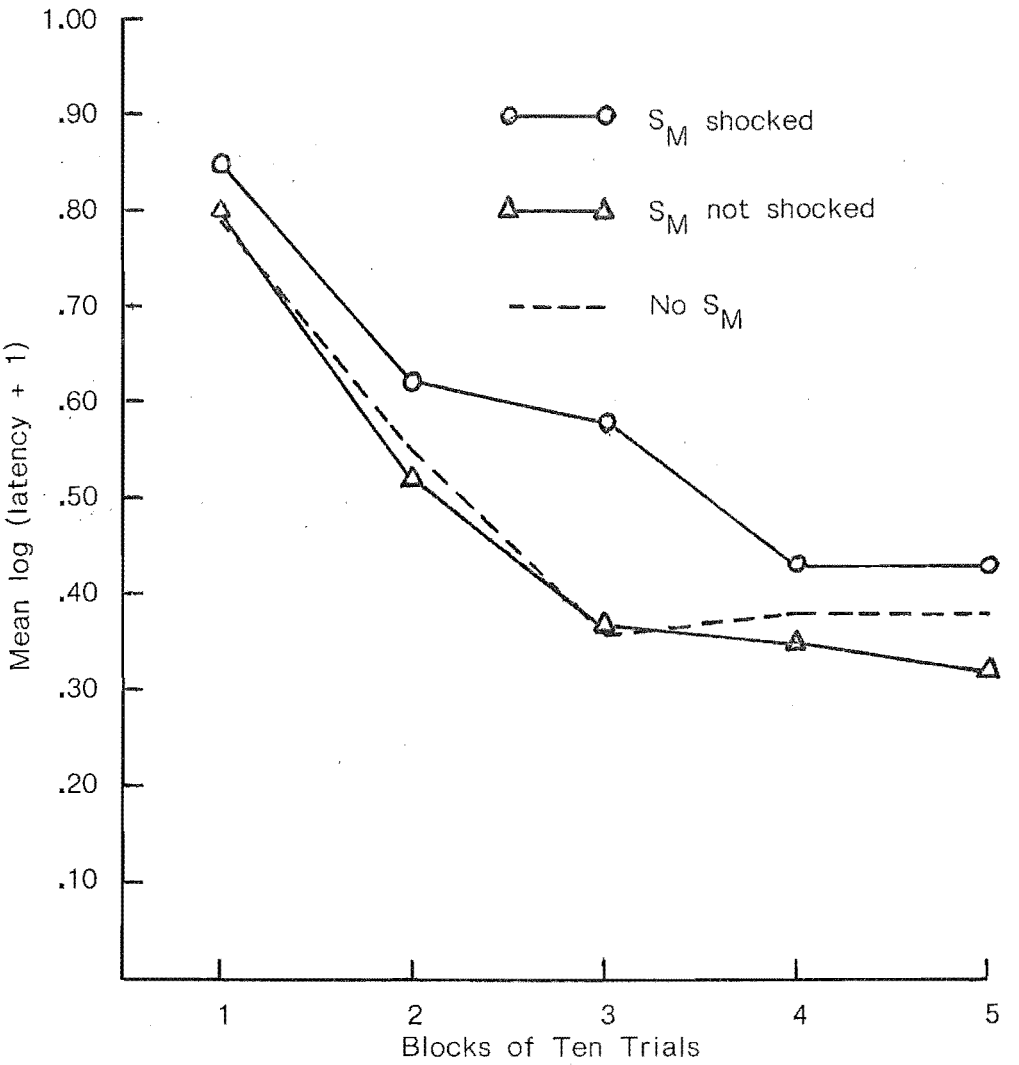

Figure 16. Transformed responses latencies during avoidance acquisition. (Experiment 5).

DISCUSSION

While the results of this experiment did not show clear disruption of avoidance acquisition, it did provide stronger evidence for the operation of directional cues related to the stressed model. That the cues were apparently not strong enough to produce disruption, as when the model was in the safe chamber, may possibly have been a function of proximity.

Further evidence on the saliency of directional cues is required. Baum and Bobrow (1966) report that shuttle avoidance is considerably improved, to compare favourably with one-one avoidance, by rotating the shuttlebox through 180° between trials, thus making the task unidirectional. This suggests that directional cues are important in accounting for the difference in rate of acquisition between one-way and shuttle avoidance, the subjects using directional cues to determine the proper response. In the present situation, the direction of safety is modified by the presence of a stressed model producing a reluctance to move in that direction. If this is so, then the addition of safety/danger cues provided by model in a two-way shuttle task should produce differences depending on whether the model is shocked or not shocked, or there is no model. Experiment 6 sought evidence relevant to this point.

EXPERIMENT 6

The finding that directional cues in relation to a stressed model may be used by subjects to modify their assessment of the safety or danger of parts of its environment, leads to the interesting hypothesis that shocking a model in the goal chamber during acquisition of shuttle avoidance should inhibit learning, when compared with model not shocked and no model conditions. This would not be predicted by an explanation of the inhibitory effect based on the notion that shocking a model in the safe chamber makes it more like the start chamber because of the stress cues laid down there or that become associated with it. On the contrary, the evidence suggests that, unlike one-way avoidance, making the two chambers distinctive leads to worse performance in shuttle avoidance (Weisman, Denny and Zerbolio, 1967; Moot, Nelson and Bolles, 1974). The converse is that the more similar the two chambers, the better the performance. Thus, an hypothesis that shocking a model in the safe chamber increases the similarity between start and safe chambers would lead to the opposite prediction that the shocked model group would show better shuttle avoidance learning than a model not shocked and no model groups.

METHOD

Subjects

Subjects were 30 male Wistar random derived albino rats. At the time of testing subjects were aged 90-120 days. Subjects were managed and assigned as in previous experiments.

Apparatus

Apparatus was the same as in Experiment 4 except that the third detachable chamber was not used and the slits in the end walls of the experimental chambers were covered with hardboard, painted white, to form the end walls.

Procedure

S_Ts were assigned to three groups of 6 subjects each. For two groups, Model Shocked and Model Not Shocked, each S_T had an accompanying S_M. In the third group, No Model Control, there were no model animals.

Each S_T was habituated to the apparatus by being allowed 3 min. free exploration of the two chambers immediately before the start of the experiment. The door beween the chambers was closed and S_T placed in one of the chambers. Half the subjects in each group were placed in the right chamber for the first trial and half in the left.

For the Model Shock group, S_M was placed in the goal chamber for that trial, given 5 sec. 1 mA shock and left for a further

20 sec. before being removed to a holding cage. The door between the chambers was then lifted and the avoidance trial started. The CS-UCS interval was 5 sec. After S_T responded a period of 20-25 sec. elapsed before the beginning of the next observation of the model. The two chambers alternated as goal and start on successive trials. In the case of the Model Not Shocked group, S_M was placed in the goal chamber for that trial and left there for 25 sec. without shock prior to each S_T avoidance trial as before. In the No Model control group the same time sequence was followed but no S_M was placed in the goal. The latency of the jumping response to the CS was recorded for each trial. For avoidance responses the CS was terminated the US was not presented in that trial.

Each subject received 15 daily sessions each of 20 trials (300 trials in total). The apparatus was thoroughly cleaned using an antiseptic and deodorizing solution following each subject's daily testing session.

RESULTS

One S_T in the Model Shocked group learned early in the experiment to successfully wedge itself in the doorway between the chambers away from shock, hence not fully completing the required response of moving to the opposite chamber. This subject was excluded from the analysis, leaving the Model Shocked group with 5 subjects.

The number of avoidance responses in each session of 20 trials was determined for each subject. The mean number of avoidance responses/session for each of the three groups is shown in Table 12 and compared in Figure 17. Two-way analysis of variance with repeated measures on sessions using the unweighted means solution for unequal groups (Winer, 1962) revealed a significant difference among groups ($F(2,14)=3.77$; $p<.05$) (Table B13). Inspection of the data indicates that the Model Shocked group made significantly less avoidance responses and did not show any substantial learning until session 11.

Despite this, analysis of transformed latency data (Table 13 and Figure 18) did not show a significant difference among groups for response latency, although this was close to significance ($F(2,14)=3.12$; $p<.10$) (Table B14). This suggests that although subjects which observed a shocked S_M were reluctant to make avoidance responses, they were nevertheless quite efficient at escaping the UCS.

The sessions factor was significant for both number of avoidance responses and latency data ($F(14,196)=17.20$; $p<.001$ and $F(14,196)=24.20$; $p<.001$, respectively). This indicates that over the 300 trials all groups made significant learning.

Group	Sessions 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
S_M Shocked	0.00	0.00	0.00	0.40	0.20	0.20	0.60	1.00	1.00	1.00	4.00	5.00	6.40	7.60	7.40
S_M Not Shocked	1.00	0.50	1.50	2.67	4.17	5.83	5.17	6.17	11.17	7.50	5.33	10.67	9.83	11.50	9.17
No S_M	1.17	0.33	2.83	5.17	5.00	6.17	8.33	8.83	10.00	11.33	11.67	11.00	12.83	14.50	12.50

Table 12. Mean number of avoidance responses/session for shuttle avoidance of Model Shocked, Model Not Shocked, and No Model groups (Experiment 6).

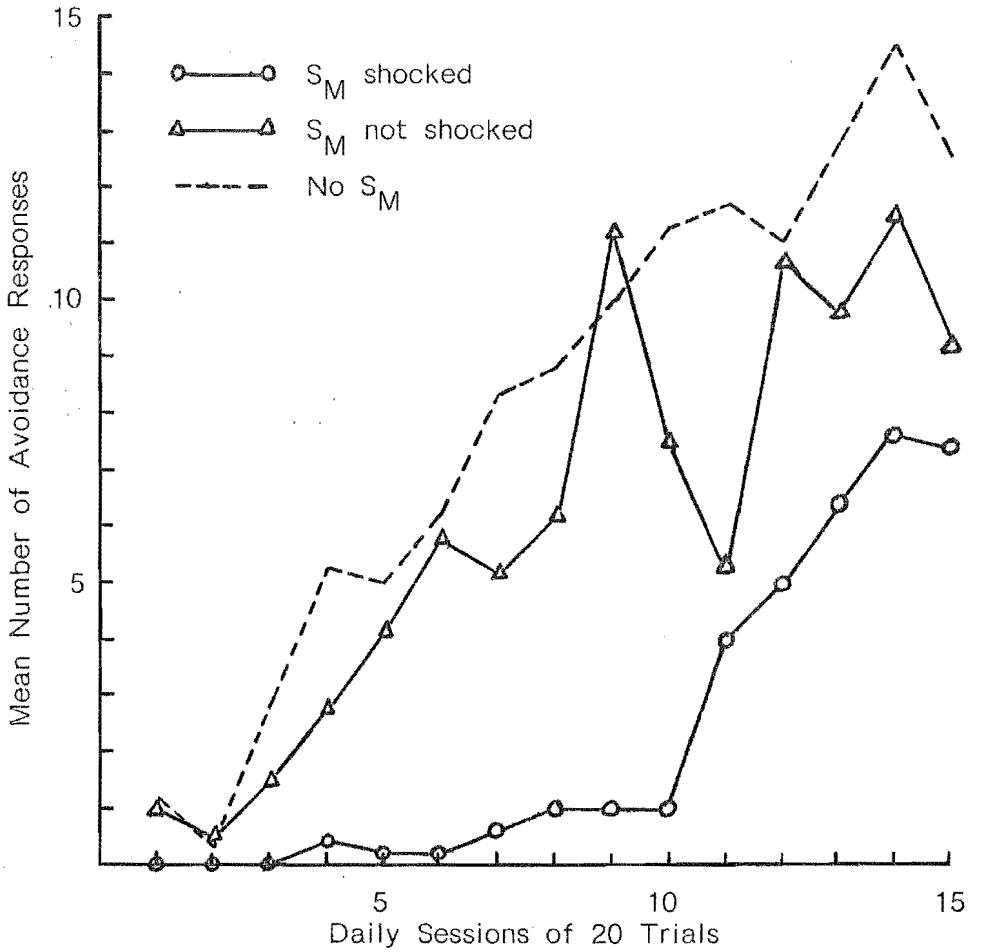

Figure 17. Comparison of shuttle avoidance acquisition for Model Shocked, Model Not Shocked and No Model groups. (Experiment 6).

Group	Sessions 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
S_M Shocked	.96	.89	.87	.85	.83	.83	.82	.80	.81	.80	.75	.73	.70	.69	.70
S_M Not Shocked	.93	.88	.84	.77	.76	.74	.76	.74	.62	.71	.75	.68	.69	.66	.66
No S_M	.89	.88	.81	.74	.73	.72	.67	.65	.65	.60	.63	.63	.61	.59	.61

Table 13. Mean transformed response latencies (log(x+1)) in shuttle avoidance for Model Shocked, Model Not Shocked and No Model groups (Experiment 6).

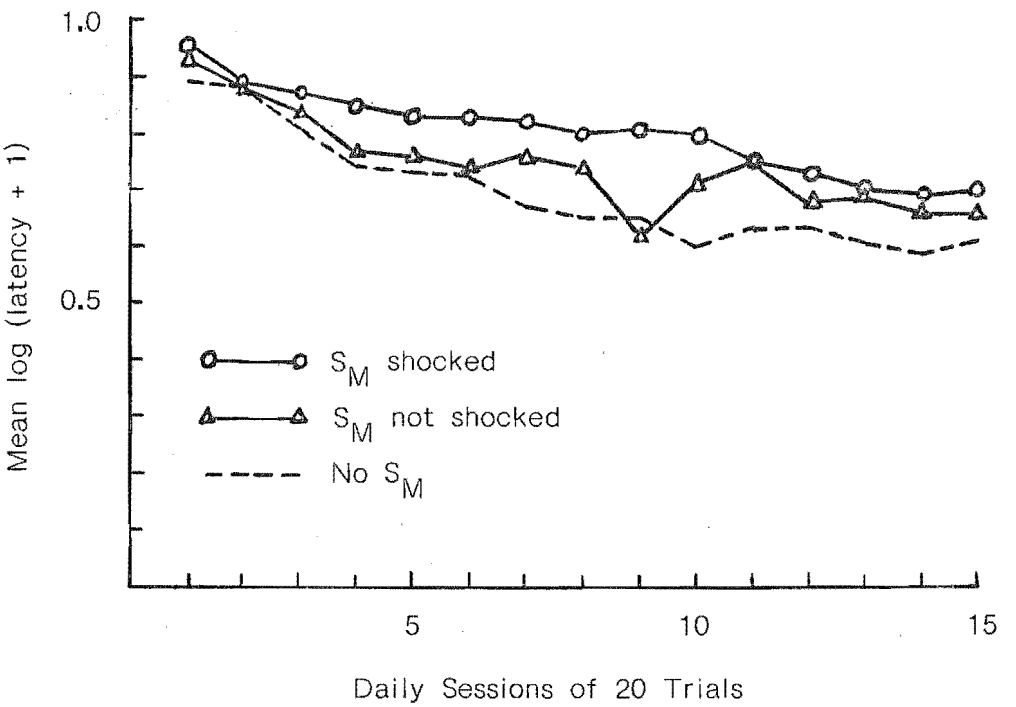

Figure 18. Comparison of transformed response latencies in shuttle avoidance for Model Shocked, Model Not Shocked and No Model groups. (Experiment 6).

DISCUSSION

The results of the experiment confirm the prediction that observation of a shocked model in the goal chamber prior to each trial of a two-way shuttle avoidance task disrupts avoidance acquisition, as in one-way avoidance. This supports the contention that the cue information provided by the shocked model is directional in nature. It does not, however, support the hypothesis that disruption of avoidance acquisition is due to the presence of the shocked model rendering the goal chamber more similar to the start chamber.

It may be that in any avoidance task in which subjects are required to move from one place to another, anything which acts as a signpost, in effect saying "this way is safety", will enhance learning of the response. Thus in one-way avoidance making the safe and start chambers distinctive provides clearer directional cues. In shuttle avoidance, however, the subject is required to change direction on each successive response, so that directional cues change values from "safe" to "danger" and it is the sign value change which is more difficult for the animal to learn. Making the two chambers more dissimilar makes the signposting more distinct and it is more difficult to change values, leading to poorer learning. Rotating the shuttle apparatus 180° between trials (Baum and Bobrow, 1966) would eliminate the necessity of sign value change of direction indicating cues (e.g. extra-apparatus cues) and improve performance.

By shocking a model in the goal for each trial we confirm the sign value encountered on the previous trial, strengthening it by providing the information "this way is danger" and hence there is greater difficulty in learning to change sign values on each trial.

In the one-way avoidance case the situation is slightly different. Here, the information from the shocked model is "this way is danger" as before, but in this case it disconfirms the sign values encountered on the previous trial, hence making the task more difficult.

One puzzling aspect of this and other experiments in this study, and in the previous experiments of Dua and Dobson (1974) is that the Model Not Shocked groups consistently performed at the same level as the No Model groups. Dua and Dobson (1974) noted this as unexpected in view of previous evidence (King and Dua, 1970). The current information hypothesis does not assist either. One would expect that a non-stressed model would confirm the directional sign values in one-way avoidance and disconfirm them in shuttle avoidance, leading to better performance in each case. However, this does not appear to happen. The only suggestion that can be offered is that in an aversive situation an animal is more attuned to danger signals than safety signals.

Bolles (1970) has suggested that safety signals are functionally equivalent to feedback signals. As feedback signals follow the response rather than precede it, it may be that such safety signals as from a non-stressed model do not become an influence until the subject has responded by removing itself from the dangerous situation. In other words, when in a dangerous situation an animal attends primarily to danger signals until it has responded in some way. Only then does it attend to feedback signals about the adequacy of its response in removing danger, i.e. safety signals. This is likely to be particularly so in circumstances where a subject receives signals from outside of the geographic location and the required response is to remove itself from that location. To put it anthropomorphically, a subject in a dangerous place might be primarily looking around for places not to go and saves its "phew" reaction (Denny's relaxation response?) to safety signals until it has gone somewhere. Bolles (1970) draws a tentative parallel between his SSDR theory of safety signals and Denny's relaxation theory (Denny and Weisman, 1964). However, the whole question of the non-effectiveness of non-stressed model cues in the current set-up requires more investigation before any definitive explanation could be attempted.

CHAPTER 5

GENERAL DISCUSSION

The investigation described in this thesis, was designed to further study the inhibitory effect first described by Dua and Dobson (1974) of a stressed model in the goal chamber on hurdle-jump avoidance. The results of the experiments suggest certain conclusions about the mechanisms involved in the interaction between subject and model in such an aversive situation.

(1) The effect does not appear to depend on inferred differences in reinforcement caused by making the safe chamber more similar to the start chamber by shocking a conspecific there. Dua and Dobson (1974) had suggested that in a one-way set-up the increase in similarity between the two chambers, by the association of olfactory cues from a stressed model with the goal chamber, would inhibit avoidance acquisition either by decreased fear reduction in the goal chamber (Miller, 1951), or by reduction in the elicitation of relaxation responses (Denny and Adelman, 1955). However, the results of the present experiments do not support such a view. Firstly, Experiments

1 and 2 show that the effect does not occur when the subject is in a third neutral observation chamber while the model is shocked. If olfactory cues were operating in the way suggested by Dua and Dobson (1974) then it would be expected that locating the subject in the observation chamber would not diminish the effect. The effects of the extra handling required to move the subject from the observation chamber do not seem to account for the differences between locating the subject in the observation chamber and the start chamber. Although handling affects avoidance acquisition, the effect is not straightforward, as shown in Experiment 3, and is not the same as for the observation chamber groups. Secondly, the results of Experiment 6 on the effect of a stressed model during two-way shuttle avoidance, clearly suggest that the presence of a stressed model in the goal chamber does not increase the similarity between the two chambers. If it did, then one would expect the effect of a stressed model would be to relatively enhance avoidance acquisition in two-way avoidance, as suggested by studies in which the two chambers are made distinctive (Moot, Nelson and Bolles, 1974).

(2) Dua and Dobson (1975) suggested that since the model receives inescapable shock it might be providing learned helplessness cues which elicit similar behaviour in the subject. However, if this were so then the same should occur when the model is shocked in the start chamber. Experiment 1 shows that this is not the case.

(3) The presence of a stressed model does not seem to produce a simple fear arousal effect that could account for disruption of avoidance acquisition. The results of Experiment 3 on the effects of handling suggested that observation of a shocked model might produce an arousal elevation which, when added to the already high arousal in the start chamber, would lead to a performance decrement in line with the Yerkes-Dodson Law. If this were the case, it would be expected that, provided the subject was in the start chamber, then the location of the shocked model would be immaterial. It was shown in Experiment 4 that shocking the model in a third chamber outside the safe/dangerous context did not produce the predicted disruption of avoidance acquisition.

(4) The effect of the stressed model on avoidance acquisition seems to require the subject to be in the start chamber when it observes the model, as shown by the results of Experiment 2. This clearly indicates that the observation of the shocked model must be observed in the context of the dangerous situation. This interpretation is supported by the evidence of Church (1959) which showed that the suppressive effect on appetitive responding of observing a shocked model is enhanced when the subject itself has undergone fear conditioning, in which shock to the subject is paired with shock to the model. Rescorla and LoLordo (1965) concluded that a stimulus will depress avoidance if previously paired with a period free of shock, but this must occur against a background in which shock also in fact occurs. It also seems

to be supported by the various studies of observational learning reviewed in Chapter 3, in which it appears that, for a stimulus which is aversive for a model to affect the behaviour of an observer, the observer must have full perceptual access to the stimulus array, model responses and the contingencies that connect them as a total complex.

(5) The results of Experiments 5 and 6 provide evidence that directional cues are important, at least in the type of avoidance task where the subject has to respond by changing geographical location to avoid a noxious stimulus. In this type of task, cues conveying information as to the safety or danger characteristics of various locations are important. It is suggested that stimuli are used as signs indicating the status of the environmental elements that confront the animal in the context of its current situation. When we change the sign values, add new signs or change the saliency of particular signs, we alter the animal's perception or cognitive map of the environment in relation to itself, which in turn modifies its behaviour.

While direction appears to be an important information variable in the present situation, others are also likely to be operating. The fact that in Experiment 5 observation of a stressed model in the direction of, but not in, the safe chamber produced a lengthening of response latency but no disruption of avoidance acquisition, i.e., the effect was present but not as strong, suggests that proximity might also be a factor. The gradients

experiments carried out by Dua and Dobson (1975) show that information about the strength or duration of the aversive stimulus from the behaviour of the model, conveyed by whatever cues, is also important.

The presence of a stressed model adds information to the total configuration of signals facing the subject. There is some evidence that rats use non-animal signals in this way also. In a pilot experiment reported as Appendix A, it was found that a preconditioned danger signal (pulsed light) presented in the safe chamber prior to each avoidance trial, delayed the occurrence of the first avoidance response in a one-way avoidance task, when compared with the effect of the same stimulus preconditioned as a safety signal. The non-animal stimulus was apparently not as powerful as that provided by a stressed model, as it was not large enough to cause disruption of avoidance acquisition or lengthening of response latencies, over-all. The effect of non-animal safety and danger signals in this type of situation requires further investigation.

What emerges from this series of experiments is the possibility that animals (or at least rats), use particular information to assess the state of parts of the environment in relation to themselves and modify their responses accordingly. The traditional two-process theories (Miller, 1948, 1951) of avoidance with their emphasis on reinforcement through the reduction of classically conditioned fear do not assist greatly in understanding the mechanisms involved in this process. In

the context of these experiments the two-process theory would have predicted either a reduction in the strength of fear in the start chamber arising from the shocking of a model, or a lesser fear reduction in the safe chamber because of fear cues provided by the model being associated with that chamber. Denny and Adelman's (1955) elicitation theory would predict similarly that the fear cues associated with the safe chamber would interfere with the elicitation of approach responses to that chamber and also reduce elicitation of relaxation responses there. While there is no reason to suppose that changes in reinforcement may not occur as the result of the presence of the shocked model, there is no direct evidence of them here. Theories which provide a more direct account of the way in which information is used by subjects are likely to be more useful in understanding the course of avoidance acquisition under these special circumstances.

The two-process theory has been shown to run into difficulties on a number of counts. These have been reviewed elsewhere (Seligman and Johnston, 1973; Mineka, 1979) and it is not proposed to embark on an extensive review of the issue here. Suffice to say that the problems encountered generally revolve around four issues.

(a) There is some difficulty in identifying what constitutes fear. Fear is manifest in three domains: (1) in physiological changes, such as increased heart rate, sweat gland activity

and blood corticosteriod levels; (2) in behavioural response systems, such as increased defaecation, suppression of consummatory and appetitive operant responding, decreased exploration, passive and active avoidance; and (3) as an emotional or "felt" experience. The first two of these have been used as indices of fear in animal and human studies. The difficulty is that they have not been found to correlate well. Thus, there has been little agreement about what constitutes the mediating fear state, the reduction of which is hypothesised by two-process theory to be the source of reinforcement for avoidance responses.

(b) Even when any of these indices of the conditioned fear response are agreed upon, there is still the difficulty that there is a desynchrony between avoidance responding and the peripheral measures of fear. It has often been observed that during the course of avoidance acquisition there is a reduction in the visible signs and the measures of fear, without an accompanying reduction in the strength of the avoidance response. Rescorla and Solomon (1967), after reviewing extensive literature, concluded that they were unable to identify any peripheral conditioned responses that could be said to reliably mediate avoidance behaviour.

This absence of concommitance between the peripheral measures of fear and avoidance lead Rescorla and Solomon (1967) to

maintain that fear is a central state, with associated but variable peripheral manifestations. Others have dispensed with fear as a mediating mechanism altogether (Herrnstein, 1969).

(c) As fear is seen as classically conditioned, its presence during avoidance must be produced by a Pavlovian CS. It is the offset of this CS which is said to reduce fear and to be reinforcing. Where there is an external CS there is no problem, but the identification of the operable CS is not always so straightforward. Such phenomena as trace avoidance conditioning, where the CS offset precedes responding and is independent of it (Kamin, 1954), and unsignalled Sidman avoidance, where an external CS is absent (Sidman, 1953), have led to the search for less obvious internal CSs, almost to reductio ad absurdum.

(d) The remarkable resistance of avoidance responses to extinction poses a serious problem for two-process theory. When a subject is responding asymptotically a large number of the trials are Pavlovian extinction trials, as the CS is not followed by the UCS. Therefore, fear to the CS should extinguish readily as do other classically conditioned responses. This in turn should lead to less reinforcement through fear reduction and extinction of the avoidance response. As mentioned above the peripheral signs of fear do seem to reduce, but avoidance does not, at least no where near as rapidly. Even the proposal of fear as a central state does

not rescue the situation, as Pavlovian extinction of this central fear state should still occur. Other interpretations, such as proposing a concept of conservation of anxiety, do not help. In this latter, it is suggested that the short latency of the avoidance response means that the subject removes itself from the presence of the CS so rapidly as to render the CS almost ineffective. But, if the CS is almost ineffective, then it will not produce the requisite fear either (Seligman and Johnston, 1973).

Seligman and Johnston (1973) have proposed a cognitive theory of avoidance which has a better fit to most known avoidance phenomena. Like traditional two-process theory it has two components. While it retains fear as a central state as one component, it confines its role to the initial elicitation of responses and imbues it with no reinforcing properties. The other component is cognitive, based on act-outcome expectations and corresponding preferences between outcomes. An expectancy is defined as "a state of the organism which represents (stores information about) contingencies between responses and outcomes in a given situation" (Seligman and Johnston, 1973, p. 90). A preference is defined as "a state of the organism which controls the choice of response on the basis of outcomes expected" (Seligman and Johnston, 1973, p. 90).

The cognitive component of the theory is stated as follows:

> "1. The animal prefers no shock ($\bar{s}$) to shock (s); that is, $\bar{s}Ps$.
> 2. The animal expects that if he responds within a given time (r_t, where t is the length of the CS-US interval in signalized avoidance, or the R-S interval in unsignalized avoidance) no shock ($\bar{s}$) rather than shock (s) will occur; that is, $r_t E\bar{s}$.
> 3. The animal expects that if he does not respond within the appropriate time ($\bar{r}_t$), shock (s) rather than no shock ($\bar{s}$) will occur; that is, $\bar{r}_t Es$.
> 4. Expectancies are strengthened when they are confirmed, and weakened when they are disconfirmed. Thus $r_t E\bar{s}$ is confirmed when r_t is followed by $\bar{s}$, and disconfirmed when it is followed by s; $\bar{r}_t Es$ is confirmed when $\bar{r}_t$ is followed by s, and disconfirmed when it is followed by $\bar{s}$.
> 5. Holding constant the preference for $\bar{s}$ rather than s, the probability of r_t is a monotonically increasing joint function of the strengths of both $r_t E\bar{s}$ and $\bar{r}_t Es$."
> (Seligman and Johnston, 1973, p. 91).

This component of Seligman and Johnston's theory seems well suited to account for the phenomenon investigated in this study.

(a) Expectancies are effective in controlling behaviour in the start chamber.

(b) Information about the state of other parts of the environment alters expectancies about the likely response-outcome contingencies. Shocking the model in the safe chamber provides information about the occurrence of shock in the safe chamber, which reduces the expectancy that that chamber will be shock free following the response of jumping into it ($r_t E\bar{s}$).

(c) The reduction in strength of $r_t E\bar{s}$ leads to a reduction in the probability of r_t, assuming that $\bar{s}Ps$ is constant.

(d) Receipt of shock in the start chamber following non-response in acquisition confirms $\bar{r}_t Es$ so that subjects do eventually learn the response.

(e) Extinction (Dua and Dobson, 1974) is faster because the strength of $r_t E\bar{s}$ is reduced, decreasing the probability of r_t and making it more likely that $\bar{r}_t Es$ will be disconfirmed.

The theory does not help in understanding why the subject apparently needs to be in the start chamber when the model is shocked in the safe chamber. It might be thought that even when in the observation chamber the expectancy of shock in the safe chamber would be altered by shocking a model there. However, this does not seem to be the case. One possibility is that there are differences in the attentional state of the animal in the two locations, one being dangerous, i.e., where shock has occurred, and one safe, i.e., where shock has not occurred. Seligman and Johnston (1973) comment that there is evidence that mere exposure to response-outcome contingencies may not be sufficient for the development of expectancies. They suggest that some theoretical mechanism or mechanisms may have to be added to effectively handle attentional phenomena.

In the discussion of Experiment 6 it was suggested that subjects may be attending to different types of signals in different situations of safety or danger. It was argued there that safety signals from a non-stressed model may not become an influence until after the subject has responded by removing itself from the dangerous situation. This would explain the apparent non-effectiveness of the presence of a non-stressed model in the safe chamber in facilitating avoidance. In terms of Seligman and Johnston's theory it might be expected that the presence of the non-stressed model would strengthen $rE\bar{s}$, which is apparently not the case.

The second component of avoidance in Seligman and Johnston's (1973) theory is fear. Although conceived of as being a classically conditioned and extinguished response, its reduction is not seen as having a reinforcing role with respect to the avoidance response. Its role is, rather, confined to the initial elicitation of responses. If 'elicitation' is seen as a process of focusing attention then a different and potentially useful way of approaching the concept of fear emerges.

Suppose that fear is redefined as a central attentional state or set in which there is a high sensitivity to danger signals and low sensitivity to safety signals. It might be referred to as a "red alert" state. This definition moves fear away from being a response to a concept more like vigilance, and returns it to a more central role in avoidance behaviour.

Such a central state would be accompanied by an increased arousal and by peripheral manifestations in the physiological, behavioural and experiential domains, which are variable according to incoming information about the environment and expectancies about available responses.

The animal is faced with the need to decide: (a) that a response is required: and (b) what response to make. If the animal, on past experience in those or similar circumstances, (or perhaps from differential evolutionary preparation of responses), has a clear expectancy that a particular response will produce the cessation of danger signals, then it will quickly make it. If, however, it has not formed such an expectancy, or only partly formed it, or the expectancy has been disconfirmed, then the high arousal will lead to manifestations of one or some combination of the various peripheral fear phenomena. Most of these changes are those associated with a system preparing for "any eventuality". If a response with a reasonable expectancy of favourable outcome is available, then such a general mobilisation is not necessary. This may not, and indeed is unlikely to be, an all-or-nothing phenomenon, which would account for the highly variable nature of peripheral fear.

The receipt of one danger signal is sufficient to shift the state of the information processing system into a fear ("red alert") set. Signals acquire their danger sign value by association with other danger signals, or may be innate because of their

special evolutionary significance. They convey information on variables such as direction, proximity (geographical and temporal), qualities of noxious events (strengths, duration, etc.), and so on.

Having made a response with an expectancy of favourable outcome (based on experience or, perhaps, based on evolutionary response preparation, SSDR?), the set switches to the receipt of feedback safety signals (relaxation?) until the receipt of the next danger signal.

Such a set theory of fear is similar in some respects to Herrnstein's (1969) theory of avoidance in which external signals are said to become discriminative stimuli which set the occasion for the avoidance response. But, whereas Herrnstein dispenses with fear, the present formulation redefines it as a specific set to receive such signals. The fear propensity system concept proposed by Leyhausen (1973) may also have some similarity to the set concept proposed here.

It must be admitted that such theorising is entirely ad hoc and there is no direct evidence in the experiments reported here that provide sufficient evidence to test this set theory of fear. Considerable development is still required. It must also be emphasised that such a theory is not intended to replace Seligman and Johnston's theory, but to add to it. Their theory of avoidance is satisfactory for accounting for most of the results of the present experiments.

The major hypothesis which arises from a set theory as outlined above is that there is a differential sensitivity to danger and safety signals in dangerous and safe situations. This might be tested by looking for differences in the degrees of suppression and enhancement of appetitive responding by previously conditioned danger and safety signals (CS^- and CS^+) in previously safe and dangerous situations, e.g., the goal and start chambers of a one-way avoidance apparatus.

It is interesting to speculate briefly on the implications of a set theory of fear in a couple of aspects of animal and human behaviour.

Firstly, it has implications for desensitisation of phobias. The procedure of systematic desensitisation (Wolpe and Lazarus, 1966) has been widely used to successfully treat phobias in humans. The process has usually been explained in terms of the gradual inhibition of the fear response by classically conditioning an incompatable response (relaxation) to the phobic stimulus, via successive approximations. However, an explanation in terms of classical conditioning does not seem to be entirely satisfactory. As Davey (1981) points out, since the therapist attempts to maintain relaxation continually throughout the session, there is no contingency between the phobic stimulus and the relaxation, and hence classical conditioning should not occur. There is evidence that there are some aspects of the procedure that do not always have to follow the same course for successful therapy: (a) systematic

structuring of the fear hierarchy does not appear to be necessary; (b) relaxation is not strictly necessary; (c) social reinforcement such as praise may be just as effective as relaxation (Davey, 1981).

By regarding fear as a set to attend to danger signals rather than as a response, i.e. by shifting it from the response domain to the perceptual or cognitive domain, we can better understand what is happening in systematic desensitisation. A phobic object or event is a source of danger signals. Construction of the fear hierarchy is a process of identifying what are the danger signals that trigger the fear set. By repeatedly presenting those danger signals (not necessarily in any particular order) in a manifestly non-aversive situation (not necessarily relaxation) their sign value is changed, so that they no longer trigger the fear set. The implication of this is that the accurate identification of the danger signals and the information that they convey is more important to successful therapy than is the use of any particular response regime, provided the situation is non-aversive or clearly "safe".

Secondly, the phenomenon of crowd or herd hysteria is difficult to explain using conventional notions of fear as a response without invoking mysterious processes of fear transfer, such as vicarious instigation. If signs of fear in conspecifics are powerful danger signals, and if, as according to the fear set theory, the receipt of a danger signal causes a change

to a fear set, then it is easy to see that fear would spread rapidly through a crowd or herd without any of the individuals being aware of what stimulus had originally triggered the fear.

Finally, this thesis was begun with some comments about the role of fear in evolution. The redefinition of fear as an attentional set akin to vigilance, makes its place in the evolutionary process even more understandable. The features in the environment in which a species develops, particularly in harsh environments, are likely to include well-defined danger signals, which in terms of promoting survival will be especially powerful in triggering a fear set. While fear might be triggered often, selection would also prepare well-established and effective responses. This would mean that the peripheral physiological manifestations, which, as outlined in Chapter 1 may be counter-productive for survival if prolonged, would not necessarily always be present.

REFERENCES

Allison, J., Larson, D. and Jensen, D.D. Acquired fear, brightness preference, and one-way shuttlebox performance. Psychonomic Science, 1967, 8, 269-270.

Allport, F.H. Social Psychology. Boston: Houghton Mifflin Co, 1924.

Amsel, A., Hug, J.L. and Surridge, C.T. Subject-to-subject trial sequence, odor trails, and patterning at 24-hr. ITI. Psychonomic Science, 1969, 15, 119-120.

Aronfreed, J. The concept of internalization. In Goslin, D.A. (Ed.) Handbook of Socialization Theory and Research. Chicago: Rand McNally, 1969.

Aulich, D. and Vossen, J.M. Behavioural conflict in two strains of rat: Home cage preference versus dark preference. Behavioural Processes, 1978, 3, 325-334.

Bandura, A. Vicarious and self-reinforcement processes. In Glaser, R. (Ed) The Nature of Reinforcement. N.Y.: Academic Press, 1971.

Bandura, A. Social Learning Theory. Englewood Cliffs, N.J.: Prentice-Hall, 1977.

Bandura, A., Blanchard, E.B. and Ritter, B. The relative efficacy of desensitization and modeling approaches for inducing behavioral, affective, and attitudinal changes. Journal of Personality and Social Psychology, 1969, 13, 173-199.

Bandura, A., Grusec, J.E. and Menlove, F.L. Vicarious extinction of avoidance behavior. Journal of Personality and Social Psychology, 1967, 5, 16-23.

Bandura, A. and Menlove, F.L. Factors determining vicarious extinction of avoidance behavior through symbolic modeling. Journal of Personality and Social Psychology, 1968, 8, 99-108.

Bandura, A. and Rosenthal, T.L. Vicarious classical conditioning as a function of arousal level. Journal of Personality and Social Psychology, 1966, 3, 54-62.

Baum, M. and Bobrow, S.A. An automated analogue of the one-way Miller-type avoidance box. Psychonomic Science, 1966, 5, 361-362.

Berger, S.M. Conditioning through vicarious instigation. Psychological Review, 1962, 69, 450-466.

Bolles, R.C. Species-specific defense reactions and avoidance learning. Psychological Review, 1970, 77, 32-48.

Bolles, R.C. Theory of Motivation (2nd edition). N.Y.: Harper and Row, 1975.

Bond, C.F. and Titus, L.J. Social facilitation: A meta-analysis of 241 studies. Psychological Bulletin, 1983, 94, 265-292.

Broadhurst, P.L. Applications of biometrical genetics to the inheritance of behaviour. In Eysenck, H.J. (Ed.) Experiments in Personality. London: Routledge and Kegan Paul, 1960.

Buck, R.W. Human Motivation and Emotion. N.Y.: John Wiley and Sons Inc., 1976.

Bunch, G.B. and Zentall, T.R. Imitation of a passive avoidance response in the rat. Bulletin of the Psychonomic Society, 1980, 15, 73-75.

Carr, W.J., Landauer, M.R. and Sonsino, R. Responses by rats to odors from living versus dead conspecifics. Behavioral and Neural Biology, 1981, 31, 67-72.

Church, R.M. Emotional reactions of rats to the pain of others. Journal of Comparative and Physiological Psychology, 1959, 52, 132-134.

Collerain, I. and Ludvigson, H.W. Aversion of conspecific odor of frustrative nonreward in rats. Psychonomic Science, 1972, 27, 54-56.

Crawford, M.P. The social psychology of vertebrates. Psychological Bulletin, 1939, 36, 407-446.

Davey, G. Animal Learning and Conditioning. London: MacMillan Press Ltd, 1981.

Davitz, J.R. and Mason, D.J. Socially facilitated reduction of a fear response in rats. Journal of Comparative and Physiological Psychology, 1955, 48, 149-151.

Del Russo, J.E. Observational learning of discriminative avoidance in hooded rats. Animal Learning and Behavior, 1975, 3, 76-80.

Denny, M.R. and Adelman, H.M. Elicitation theory: I. An analysis of two typical learning situations. Psychological Review, 1955, 62, 290-296.

Denny, M.R. and Weisman, R.G. Avoidance behavior as a function of length of nonshock confinement. Journal of Comparative and Physiological Psychology, 1964, 58, 252-257.

Dua, J.K. Avoidance acquisition and extinction as a function of start and safe box times in rats. Indian Journal of Psychology, 1975, 50, 279-291.

Dua, J.K. Effect of audience on the acquisition and extinction of avoidance. British Journal of Social and Clinical Psychology, 1977, 16, 207-212.

Dua, J.K. and Dobson, M.J. Role of olfactory cues in acquisition and extinction of avoidance. Journal of Experimental Psychology, 1974, 103, 461-465.

Dua, J.K. and Dobson, M.J. Gradients of olfactory cues in avoidance. Effect of shock intensity and duration of shock. Indian Journal of Psychology, 1975, 50, 122-132.

Funkenstein, D.H. The physiology of fear and anger. Scientific American, 1955, 192(5), 74-80.

Galef, B.G., Jnr. Social transmission of acquired behavior: A discussion of tradition and social learning in vertebrates. In Rosenblatt, J.S, Hinde, R.A., Shaw, E., and Beer, C. (Eds.) Advances in the Study of Behavior. 6. N.Y.: Academic Press, 1976

Geen, R.G. and Gange, J.J. Drive theory of social facilitation: Twelve years of theory and research: Psychological Bulletin, 1977, 84, 1267-1288.

Gellhorn, E. Principles of Autonomic-somatic Integrations. Minneapolis: University of Minnesota Press, 1967.

Gray, J.A. The Psychology of Fear and Stress. London: Weidenfeld and Nicolson, 1971.

Green, G. and Osborne, J.G. Does vicarious instigation provide support for observational learning theories? A critical review. Psychological Bulletin, 1985, 97, 3-17.

Hake, D.F. and Laws, D.R. Social facilitation of responses during a stimulus paired with electric shock. Journal of Experimental Analysis of Behavior, 1967, 10, 387-392.

Hall, C.S. The genetics of behavior. In Stevens, S.S. (Ed.) Handbook of Experimental Psychology. N.Y.: Wiley, 1951.

Hall, C.S. Temperament: A survey of animal studies. Psychological Bulletin, 1941, 38, 909-943.

Harlow, H.F. Social facilitation and feeding in the albino rat. Journal of Genetic Psychology, 1932, 43, 211-221.

Harlow, H.F. and Yudin, H.C. Social behavior of primates: I. Social facilitation of feeding in the monkey and its relations to attitudes of ascendance and submission. Journal of Comparative Psychology, 1933, 16, 171-185.

Hebb, D.O. On the nature of fear. Psychological Review, 1949, 53, 250-275.

Herrnstein, R.J. Method and theory in the study of avoidance. Psychological Review, 1969, 76, 49-69.

Hughes, R.N. Social facilitation of locomotion and exploration in rats. British Journal of Psychology, 1969, 60, 385-388.

Hygge, S. Emotional and electrodermal reactions to the suffering of another: Vicarious instigation and vicarious classical conditioning. (Studia Psychologica Upsaliensia 2). Uppsala, Sweden: Acta Universitatis Upsaliensis, 1976(a).

Hygge, S. Information about the model's unconditional stimulus and response in vicarious classical conditioning. Journal of Personality and Social Psychology, 1976(b), 33, 764-771.

Jackson, R., Alexander, J. and Maier, S. Learned helplessness, inactivity and associative deficits: Effects of inescapable shock on response choice escape learning. Journal of Experimental Psychology: Animal Behavior Processes, 1980, 6, 1-20.

James, W.T. Social facilitation of eating behavior in puppies after satiation. Journal of Comparative and Physiological Psychology, 1953, 46, 427-428.

James, W.T. The development of social facilitation of eating in puppies. Journal of Genetic Psychology, 1960, 96, 123-127.

John, E.R., Chesler, P., Bartlett, F. and Victor, I. Observation learning in cats. Science, 1968, 159, 1489-1491.

Kamin, L.J. Traumatic avoidance learning: The effects of CS-US interval with a three-conditioning procedure. Journal of Comparative and Physiological Psychology, 1954, 47, 65-72.

Kavanau, J.L. Compulsory regime and control of environment in animal behaviour IV. Light level preferences of cactus mice, Peromyscus eremicus. Behaviour, 1978, 65, 161-181.

King, M.G. Stimulus generalization of conditioned fear in rats over time: Olfactory cues and adrenal activity. Journal of Comparative and Physiological Psychology, 1969, 69, 590-600.

King, M.G. and Dua, J.K. Cues eliciting social approach in male albino rats. Psychonomic Science, 1970, 21, 258-259.

Kirk, R.L. Experimental Design: Procedures for the behavioral sciences. Belmont, Calif.: Brooks/Cole Publishing Company, 1968.

Knapp, R.K. Acquisition and extinction of avoidance with similar and different shock and escape situations. Journal of Comparative and Physiological Psychology, 1965, 60, 272-273.

Lambert, K. and Gorfein, D. An experimental study of what is learned in a shuttlebox situation. Canadian Journal of Psychology, 1958, 12, 222-229.

Leyhausen, P. On the natural history of fear. In Lorenz, K. and Leyhausen, P. (Trans. by B.A. Tonkin) Motivation of Human and Animal Behavior: An Ethological View. N.Y.: Van Nostrand Reinhold Co., 1973.

Lore, R, Blanc, A. and Suedfeld, P. Empathetic learning of a passive avoidance response in domesticated Rattus norvegicus. Animal Behavior, 1971, 19, 112-114.

McFarland, D. Animal Behaviour. London: Pitman, 1985.

Mackay-Sim, A. and Laing, D.G. Discrimination of odors from stressed rats by non-stressed rats. Physiology and Behavior, 1980, 24, 699-704.

Mackay-Sim, A. and Laing, D.G. The sources of odors from stressed rats. Physiology and Behavior, 1981(a), 27, 511-513.

Mackay-Sim, A. and Laing, D.G. Rats' responses to blood and body odors of stressed and non-stressed conscecifics. Physiology and Behavior, 1981(b), 27, 503-510.

Maier, S.F. and Seligman, M.E.P. Learned helplessness: Theory and evidence. Journal of Experimental Psychology: General, 1976, 105, 3-46.

Marina, J.F. and Bauermeister, J.J. Socially facilitated extinction of a conditioned avoidance response. Bulletin of the Psychonomic Society, 1974, 3, 161-163.

Marr, J.N. and Gardner, L.E., Jnr. Early olfactory experience and later social behavior in the rat: Preference, sexual responsiveness and care of young. Journal of Genetic Psychology, 1965, 107, 167-174.

Mason, J.W. and Brady, J.V. The sensitivity of psychoendocrine systems to social and physical environment. In Leiderman, P. and Shapiro, D (Eds) Psychobiological Approaches to Social Behavior. Stanford, Calif.: Stanford University Press, 1964.

Masserman, J.H. Behavior and Neurosis. Chicago: University of Chicago Press, 1943.

Means, L.W., Hardy, W.T., Gabriel, M. and Uphold, J.D. Utilization of odor trails by rats in maze learning. Journal of Comparative and Physiological Psychology, 1971, 76, 160-164.

Mellgren, R.L., Foutts, R.S. and Martin, L.W. Approach and escape to conspecific odors of reward and nonreward in rats. Animal Learning and Behavior, 1973, 1, 129-132.

Miller, N.E. Studies of fear as an acquirable drive. I. Fear as motivation and fear reduction as reinforcement in the learning of new responses. Journal of Experimental Psychology, 1948, 38, 89-101.

Miller, N.E. Learnable drives and rewards. In Stevens, S.S. (Ed.) Handbook of Experimental Psychology. N.Y.: Wiley, 1951.

Miller, R.E. Experimental approaches to the physiological and behavioural concomitants of affective communication in rhesus monkeys. In Altmann, S.A (Ed.) Social Communication Among Primates. Chicago: University of Chicago Press, 1967.

Miller, R.E., Banks, J. and Ogawa, N. The role of facial expression in "cooperative-avoidance" conditioning in monkeys. Journal of Abnormal and Social Psychology, 1963, 67, 24-30.

Mineka, S. The role of fear in theories of avoidance learning, flooding and extinction. Psychological Bulletin, 1979, 86, 985-1010.

Moot, S.A., Nelson, K. and Bolles, R.C. Avoidance learning in a black and white shuttlebox. Bulletin of the Psychnomic Society, 1974, 4, 501-501.

Morgan, P.A. and Howse, P.E. Avoidance conditioning of jackdaws (Corvus monedula) to distress calls. Animal Behavior, 1973, 21, 481-491.

Morrison, R.R. and Ludvigson, H.W. Discrimination by rats of conspecific odors of reward and nonreward. Science, 1970, 167, 904-905.

Presley, W.J. and Riopelle, A.J. Observational learning of an avoidance response. Journal of Genetic Psychology, 1959, 95, 251-254.

Rachman, S.J. The Meanings of Fear. Harmondsworth: Penguin, 1974.

Rachman, S.J. Fear and Courage. San Francisco, Calif.: W.M. Freeman & Co., 1978.

Rasmussen, E.W. Social facilitation: An experimental investigation with albino rats. Acta Psychologica, 1939, 4, 275-294.

Rescorla, R.A. and LoLordo, V.M. Inhibition of avoidance behavior. Journal of Comparative and Physiological Psychology, 1965, 59, 406-412.

Rescorla, R.A. and Solomon, R.L. Two-process learning theory: relationships between Pavlovian conditioning and instrumental learning. Psychological Review, 1967, 74, 151-182.

Reynierse, J.H. and Rizley, R.C. Relaxation and fear as determinants of maintained avoidance in rats. Journal of Comparative and Physiological Psychology, 1970, 72, 223-232.

Riess, D. Vicarious conditioned acceleration: Successful observational learning of an aversive Pavlovian stimulus contingency. Journal of the Experimental Analysis of Behavior, 1972, 18, 181-186.

Seligman, M.E.P. On the generality of the laws of learning. Psychological Review, 1970, 77, 406-418.

Seligman, M.E.P. Phobias and preparedness. In Seligman, M.E.P. and Hager, J.L. (Eds.) Biological Boundaries of Learning. N.Y.: Appleton-Century-Crofts, 1972.

Seligman, M.E.P. and Hager, J.L. (Eds) Biological Boundaries of Learning. N.Y.: Appleton-Century-Crofts, 1972.

Seligman, M.E.P. and Johnston, J.C. A cognitive theory of avoidance learning. In McGuigan, F.T. and Lumsden, D.B. (Eds.) Contemporary Approaches to Conditioning and Learning. Washington: H.V. Winston and Sons, 1973.

Seligman, M.E.P. and Maier, S.F. Failure to escape traumatic shock. Journal of Experimental Psychology, 1967, 74, 1-9.

Seligman, M.E.P., Maier, S.F. and Solomon, R.L. Unpredictable and uncontrollable aversive events. In Brush, F.R. (Ed.) Aversive Conditioning and Learning. N.Y.: Academic Press, 1971.

Sidman, M. Avoidance conditioning with brief shock and no exteroceptive warning signal. Science, 1953, 46, 253-261.

Sluckin, W. Imprinting and Early Learning. London: Methuen, 1964.

Smith, W.I. and Ross, S. The social behavior of vertebrates: A review of the literature (1939-1950). Psychological Bulletin, 1952, 49, 598-627.

Sprott, R.L. "Fear communication" via odor in inbred mice. Psychological Reports, 1969, 25, 263-268.

Thelen, M.H. and Rennie, D.L. The effect of vicarious reinforcement on imitation: A review of the literature. In Maher, B.A. (Ed.) Progress in Experimental Personality Research. N.Y.: Academic Press, 1972.

Thiessen, D.D. Population density, mouse genotype, and endocrine function in behavior. Journal of Comparative and Physiological Psychology, 1964(a), 57, 412-416.

Thiessen, D.D. Amphetamine toxicity, population density, and behavior: A review. Psychological Bulletin, 1964(b), 62, 401-410.

Tolman, C.W. Social facilitation of feeding behavior in the domestic chick. Animal Behavior, 1964, 12, 245-251.

Tolman, C.W. Emotional behavior and social facilitation of feeding in domestic chicks. Animal Behavior, 1965, 13, 493-496.

Tolman, C.W. and Wilson, G.F. Social feeding in domestic chicks. Animal Behavior, 1965, 13, 134-142.

Wahlsten, D., Cole, M., Sharp, D. and Fantino, E. Facilitation of bar-press avoidance by handling during the intertrial interval. Journal of Comparative and Physiological Psychology, 1968, 65, 170-175.

Wahlsten, D. and Sharp, D. Improvement of shuttle avoidance by handling during the intertrial interval. Journal of Comparative and Physiological Psychology, 1969, 67, 252-259.

Weisman, R.G., Denny, M.R. and Zerbolio, D.J. Discrimination based on differential nonshock confinement in a shuttle box. Journal of Comparative and Physiological Psychology, 1967, 63, 34-38.

West, G.B. The comparative pharmacology of the suprarenal medulla. Quarterly Review of Biology, 1955, 30, 116-137.

Wheeler, L. and Davis, H. Social disruption of performance on a DRL schedule. Psychonomic Science, 1967, 7, 249-250.

Winer, B.J. Statistical Principles in Experimental Design. N.Y.: McGraw Hill Book Company Inc., 1962.

Wolpe, J. and Lazarus, A.A. Behaviour Therapy Techniques: A Guide to the Treatment of Neuroses. N.Y.: Pergamon Press, 1966.

Zajonc, R.B. Social facilitation. Science, 1965, 149, 269-274.

Zajonc, R.B. Animal Social Psychology. N.Y.: John Wiley and Sons Inc., 1969.

APPENDIX A

Effect of Danger and Safety Signals in the Goal Chamber on Avoidance Acquisition: A Pilot Experiment

The finding in the main body of this thesis that rats appear to use cues from a stressed model in the safe chamber of an avoidance apparatus, in both one-way and two-way experimental situations, as danger signals raises the question as to whether rats also use non-animal danger signals in the same way. The results of the experiments described in the present thesis and by Dua and Dobson (1974, 1975) show that shocking a model in the safe chamber produces inhibition of avoidance acquisition, under certain circumstances.

Previous studies have shown that stimuli classically conditioned to either predict shock (CS^+) or predict non-shock (CS^-) will produce enhancement of avoidance responding or suppression of avoidance responding, respectively (Rescorla and LeLordo, 1965; Rescorla, 1967; Grossen and Bolles, 1968). From these results it could be expected that if the shocked model acts as a danger signal (CS^+) then it should enhance avoidance acquisition; conversely if the unshocked model acts as a safety signal (CS^-) then it should inhibit avoidance acquisition. This is contrary to the results mentioned above.

The present preliminary experiment explores whether previously conditioned non-animal danger and safety signals when delivered in the safe chamber of a one-way avoidance set-up operate in the same way as shocked and non-shocked models. If previously conditioned non-animal stimuli are similar in effect

to models, then it is predicted that a group for which danger signals are present in the goal chamber will produce slower avoidance when compared with a group for which safety signals are presented in the goal chamber.

METHOD

Subjects

Subjects were 24 male Wistar random derived albino rats aged 90-120 days at the time of testing. Subjects were housed four to a cage from weaning at 21 days with ad-lib food and water. They were handled for about 3 minutes each day for two days prior to the start of preconditioning. All subjects in a cage were assigned to the same group.

Apparatus

The apparatus was a shuttle-box consisting of two identical chambers, each 305mm long by 205mm wide and 190mm in height, of stainless steel construction with a semi-silvered glass observation panel extending along the whole of one side, from about half the height of the wall to the top. Each chamber was covered by a translucent white plastic lid behind which was mounted a bulb to illuminate the chamber. The chambers were separated by a stainless steel dividing wall with a guillotine door of transparent plastic 90mm in height by 100mm wide. The bottom of the door opening was flush with the grid floor. The floor of the chambers consisted of stainless steel grids

through which footshock was delivered. The grid floor in each chamber was independently sprung with a microswitch beneath and counterbalanced such that the weight of a rat depressed the floor and operated the switch to record the entry of the subject into the chamber.

The CS for avoidance trials (CS_a) was a 2.8 KHz tone of 70 dB against a background of 40 dB. The UCS was a 1.0 mA shock delivered to the feet of subjects through the floor grids. The CS-UCS interval was 4 sec. An initiate switch turned on CS_a, a clock to measure response latency and a timer which turned on the UCS after 4 sec. and operated the mechanism which opened the door. CS_a, UCS and the response latency clock remained on until cancelled by the operation of the floor switch caused by the subject entering the goal chamber. The floor switch also operated the mechanism to close the door.

Preconditioning was carried out in a detached chamber identical to the other two. The CS was the chamber lid light which was pulsed on (0.5 sec.) and off (0.5 sec.) for 1 minute (CS_s). The UCS was 1 mA foot shock.

Procedure

Subjects were assigned to either a danger signal (DS) or a safety signal (SS) group consisting of 12 subjects each.

Preconditioning Subjects were given 5 daily sessions of preconditioning. In each session 10 presentations of CS_s and UCS on a random variable schedule over 40 minutes. All subjects received the same schedule. For the DS group a 5 sec. 1 mA shock occurred on CS_s offset; for the SS group a 5 sec. 1 mA shock immediately preceded the onset of CS_s.

Hence for the DS group CS_s was associated with shock onset and signalled shock, while for the SS group CS_s was associated with shock offset and signalled no shock. The chamber light was on between presentations of CS_s.

Testing. Testing was carried out on the day following the last preconditioning session. The subject was given 3 minutes of habituating free exploration of the start and goal chambers. The door was then closed and the subject placed in the start chamber, with both chambers illuminated. The safe chamber light was then pulsed for 1 minute (CS_s) immediately before the start of the avoidance trial. The subject was left in the safe chamber for 20-25 sec. before being returned to the start box for the next trial. Each subject received 30 trials and the latency of the response of moving into the safe chamber was measured. For avoidance responses CS_a was terminated and UCS not presented on that trial. The chamber lights remained on throughout, except when pulsed in the safe chamber.

The apparatus was thoroughly cleaned by washing with an antiseptic and deodorising solution after each subject's testing session.

RESULTS

The 30 trials were divided into six blocks of five trials each and the number of avoidance responses determined for each block for each subject. The mean number of avoidance responses/block is shown in Table A1. Two-way analysis of variance with repeated measures on trial blocks revealed significant learning in both groups ($F(5,110)=51.08$; $p<.001$) but no difference between groups ($F(1,22)=1.25$) and no significant groups x trial blocks interaction ($F(5,110)=0.71$).

Response latencies were transformed using a log (latency + 1) transformation. Mean transformed latencies are shown in Table A2. Analysis of variance of this data revealed a similar pattern as the number of responses data. There was a significant reduction in latency for both groups ($F(5,110=83.43$; $p<.001$) but no significant difference between groups ($F(1,22)=0.14$) and no significant interaction ($F(5,110)=0.77$).

Analysis of the number of trials to the first avoidance response indicated that the DS group took longer to make its first avoidance response with a mean of 6.28 responses, compared with the SS group which had a mean of 4.08. The difference between these means was significant ($F(1,22)=5.23$; $p<.05$). Thus, although the groups did not differ in the number of avoidance responses overall, the DS appeared to have delayed avoidance responding.

Group	1	2	3	4	5	6
DS	0.50	3.00	3.33	4.08	4.58	4.75
SS	1.50	3.17	3.92	4.50	4.67	5.00

Table A1. Mean number of avoidance responses on each block of five trials for DS and SS groups.

Group	1	2	3	4	5	6
DS	.90	.63	.56	.49	.44	.41
SS	.82	.62	.56	.48	.43	.43

Table A2. Mean transformed response latencies for DS and SS groups.

DISCUSSION

The results provide tentative evidence that previously conditioned non-animal danger signals emanating from the safe chamber can interfere with avoidance responding in the same way as stressed models do, although not nearly as strongly. Certainly they seem not to act in the same way as reported in other studies (Rescorla and LoLordo, 1965; Rescorla, 1967; Grossen and Bolles, 1968) where danger signals (CS^+) produced enhancement of responding in a Sidman avoidance task and safety signals produced suppression. However, in those studies the stimuli were tones and were not meant to be localised. In the present experiment a visual stimulus was deliberately chosen as it could be clearly located in the goal chamber.

The present experiment provides some evidence favouring rats' use of danger cues to modify the way in which they respond in an aversive situation. It also suggests that the cues provided by stressed conspecifics are particularly powerful in their effect. It may be that the preconditioning in the present experiment was insufficient or the shock used in preconditioning was not strong enough to produce powerful danger signals. Also, since preconditioning with non-correlated CS/shock and shock alone are reported by Grossen and Bolles (1968), to produce interesting mixed enhancement and suppressive effects, it would be as well to include such groups in this type of experiment. These are matters for further investigation.

REFERENCES

Dua, J.K. and Dobson, M.J. Role of olfactory cues in acquisition and extinction of avoidance. Journal of Experimental Psychology, 1974, 103, 461-465.

Dua, J.K. and Dobson, M.J. Gradients of olfactory cues in avoidance. Effect of shock intensity and duration of shock. Indian Journal of Psychology, 1975, 50, 122-132.

Grossen, N.E. and Bolles, R.C. Effects of a classical conditioned 'fear signal' and 'safety signal' on nondiscriminated avoidance behavior. Psychonomic Science, 1968, 11, 321-322.

Rescorla, R.A. Pavlovian conditioning and its proper control procedures. Psychological Review, 1967, 74, 71-80.

Rescorla, R.A. and LeLordo, V. Inhibition of avoidance behavior. Journal of Comparative and Physiological Psychology, 1965, 59, 406-412.

APPENDIX B

Analysis of Variance Summary Tables

Source	SS	df	MS	F	p
Between Subjects	232.72	39			
A (groups)	18.37	4	4.59	0.75	
Subj. w. grps	214.35	35	6.12		
Within Subjects	1059.20	160			
B (trial blocks)	765.67	4	191.42	96.68	<.001
AB	16.88	16	1.06	0.54	
B x subj. w. grps	276.65	140	1.98		

Table B1. Summary of analysis of variance. Number of avoidance responses/block of 10 trials (Experiment 1)

Source	SS	df	MS	F	p
Between subjects	0.95	39			
A (groups)	0.18	4	0.045	2.05	
Subj. w. grps	0.77	35	0.022		
Within Subjects	6.04	160			
B (trial blocks)	4.45	4	1.1125	105.95	<.001
AB	0.12	16	0.0075	0.71	
B x subj. w. grps	1.47	140	0.0105		

Table B2. Summary of analysis of variance. Transformed response latency (log(x+1)) averaged over each 10 trial block (Experiment 1)

Source	SS	df	MS	F	p
Between Subjects	189.5	31			
A (model location)	0.1	1	0.1	0.02	
B (model condition)	0.03	1	0.03	0.005	
AB	18.21	1	18.21	2.98	
Subj. w. grps	171.15	28	6.11		
Within Subjects	858.4	128			
C (trial blocks)	620.84	4	155.21	77.66	<.001
AC	3.46	4	0.87	0.44	
BC	8.28	4	2.07	1.04	
ABC	1.97	4	0.49	0.25	
C x subj. w. grps	223.85	112	2.00		

Table B3. Summary of three-way analysis of variance for number of trials/block for groups with model subject (Experiment 1)

Source	SS	df	MS	F	p
Between Subjects	0.75	31			
A (model location)	0.04	1	0.04	1.96	
B (model condition)	0.03	1	0.03	1.47	
AB	0.11	1	0.11	5.40	<.05
Subj. w. grps	0.57	28	0.02		
Within Subjects	4.76	128			
C (trial blocks)	3.54	4	0.89	87.44	<.001
AC	0	4	0	0	
BC	0.05	4	0.013	1.28	
ABC	0.03	4	0.008	0.79	
C x subj. w. grps (error within)	1.14	112	0.01		

Table B4. Summary of three-way analysis of variance for transformed latency data for groups with model subject (Experiment 1)

Source	SS	df	MS	F	p
Between Subjects	756.60	47			
A (location of S_T)	135.00	1	135.00	14.61	<.001
B (condition of S_M)	149.58	2	74.79	8.09	<.005
AB	83.92	2	41.96	4.54	<.05
Subj. w. grps (error between)	388.10	42	9.24		
Within Subjects	1582.40	192			
C (trial blocks)	1105.79	4	276.45	116.21	<.001
AC	9.04	4	2.26	0.95	
BC	45.26	8	5.66	2.38	<.05
ABC	22.66	8	2.83	1.19	
C x subj. w. grps (error within)	399.65	168	2.38		

Table B5. Summary of analysis of variance (location of S_T x S_M condition x trial blocks) of mean number of avoidance responses/block of 10 trials (Experiment 2)

Source	SS	df	MS	F	p
Between Subjects	3.54	47			
A (location of S_T)	0.62	1	0.62	15.76	<.001
B (condition of S_M)	0.81	2	0.405	10.30	<.001
AB	0.46	2	0.23	5.85	<.01
Subj. w. grps (error between)	1.65	42	0.039		
Within Subjects	7.65	192			
C (trial blocks)	5.75	4	1.4375	145.20	<.001
AC	0.03	4	0.0075	0.76	
BC	0.16	8	0.02	2.02	<.05
ABC	0.05	8	0.0063	0.64	
C x subj. w. grps (error within)	1.66	168	0.0099		

Table B6. Summary of analysis of variance (location of S_T x S_M condition x trial blocks) of mean transformed response latencies (Experiment 2)

Source	SS	df	MS	F	p
Between Subjects	812.60	47			
A (treatment of S_T)	7.01	1	7.01	0.52	
B (condition of S_M)	87.56	2	43.78	3.23	<.05
AB	148.81	2	74.41	5.49	<.01
Subj. w. grps (error between)	569.22	42	13.55		
Within Subjects	1846.40	192			
C (trial blocks)	1240.56	4	310.14	110.37	<.001
AC	18.56	4	4.64	1.65	
BC	13.82	8	1.73	0.62	
ABC	101.56	8	12.70	4.52	<.01
C x subj. w. grps (error within)	471.90	168	2.81		

Table B7. Summary of analysis of variance (treatment of S_T x condition of S_M x trial blocks) of mean number of avoidance responses/block of 10 trials (Experiment 3)

Source	SS	df	MS	F	p
Between Subjects	3.55	47			
A (treatment of S_T	0.0	1	0.0	0.0	
B (condition of S_M)	0.49	2	0.25	4.63	<.05
AB	0.79	2	0.40	7.40	<.01
Subj. w. grps (error between)	2.27	42	0.05		
Within Subjects	8.41	192			
C (trial blocks)	6.45	4	1.61	164.18	<.001
AC	0.06	4	0.015	1.53	
BC	0.06	8	0.008	0.76	
ABC	0.19	8	0.024	2.42	<.05
C x Subj. w. grps (error within)	1.65	168	0.001		

Table B8. Summary of analysis of variance (treatment of S_T x condition of S_M x trial blocks) for mean log (latency +1) (Experiment 3)

Source	SS	df	MS	F	p
Between Subjects	214.69	31			
A (location of S_M)	8.55	1	8.55	1.31	
B (condition of S_M)	1.05	1	1.05	0.16	
AB	21.77	1	21.77	3.33	
Subj. w. grps (error between)	183.32	28	6.55		
Within Subjects	1046.8	128			
C (trial blocks)	808.65	4	202.16	106.65	<.001
AC	4.35	4	1.09	0.58	
BC	16.35	4	4.09	2.16	
ABC	5.15	4	1.29	0.68	
C x subj. w. grps (error within)	212.3	112	1.90		

Table B9. Summary of analysis of variance (S_M location x S_M condition by trial blocks) of number of avoidance responses/block of 10 trials (Experiment 4)

Source	SS	df	MS	F	p
Between Subjects	1.11	31			
A (location of S_M)	0.06	1	0.06	1.81	
B (location of S_M)	0.0	1	0.0	0.0	
AB	0.12	1	0.12	3.61	
Subj. w. grps (error between)	0.93	28	0.03		
Within Subjects	4.06	128			
C (trial blocks)	3.20	4	0.80	121.08	<.001
AC	0.02	4	0.005	0.76	
BC	0.03	4	0.008	1.21	
ABC	0.07	4	0.02	2.65	<.05
C x subj. w. grps (error within)	0.74	112	0.007		

Table B10. Summary of analysis of variance (S_M location x S_M condition x trial blocks) of mean transformed response latencies (Experiment 4)

Source	SS	df	MS	F	p
Between Subjects	104.37	23			
Groups	7.02	2	3.51	0.76	
Subjects w. grps	97.35	21	4.64		
Within Subjects	989.00	96			
Trial Blocks	745.37	4	186.34	69.60	<.001
Groups x Blocks	18.73	8	2.34	0.87	
B x Subjects w. grps	224.90	84	2.68		

Table B11. Summary of analysis of variance. Number of avoidance responses/block of 10 trials (Experiment 5)

Source	SS	df	MS	F	p
Between Subjects	0.90	23			
Groups	0.27	2	0.135	4.50	<.05
Subjects w. grps	0.63	21	0.03		
Within Subjects	4.40	96			
Blocks	3.17	4	0.793	59.97	<.001
Groups x Blocks	0.12	8	0.015	1.14	
B x Subjects w. grps	1.11	84	0.013		

Table B12. Summary of analysis of variance of mean transformed response latencies (Experiment 5)

Source	SS	df	MS	F	p
Between Subjects		16			
Groups	1464.99	2	732.29	3.77	<.05
Subjects w. grps	2720.60	14	194.33		
Within Subjects		238			
Sessions	2847.99	14	203.43	17.20	<.001
Groups x sessions	476.92	28	17.03	1.44	
Sessions x Subj.w.grps	2318.17	196	11.83		

Table B13. Summary of analysis of variance. Number of avoidance responses/session for shuttle avoidance (Experiment 6).

Source	SS	df	MS	F	p
Between Subjects		16			
Groups	0.507	2	0.253	3.12	
Subjects w. grps	1.136	14	0.081		
Within Subjects		238			
Sessions	1.689	14	0.121	24.20	<.001
Groups x Sessions	0.113	28	0.004	0.80	
Sessions x Subj.w.grps	0.963	196	0.005		

Table B14. Analysis of variance of transformed latency data (Experiment 6).